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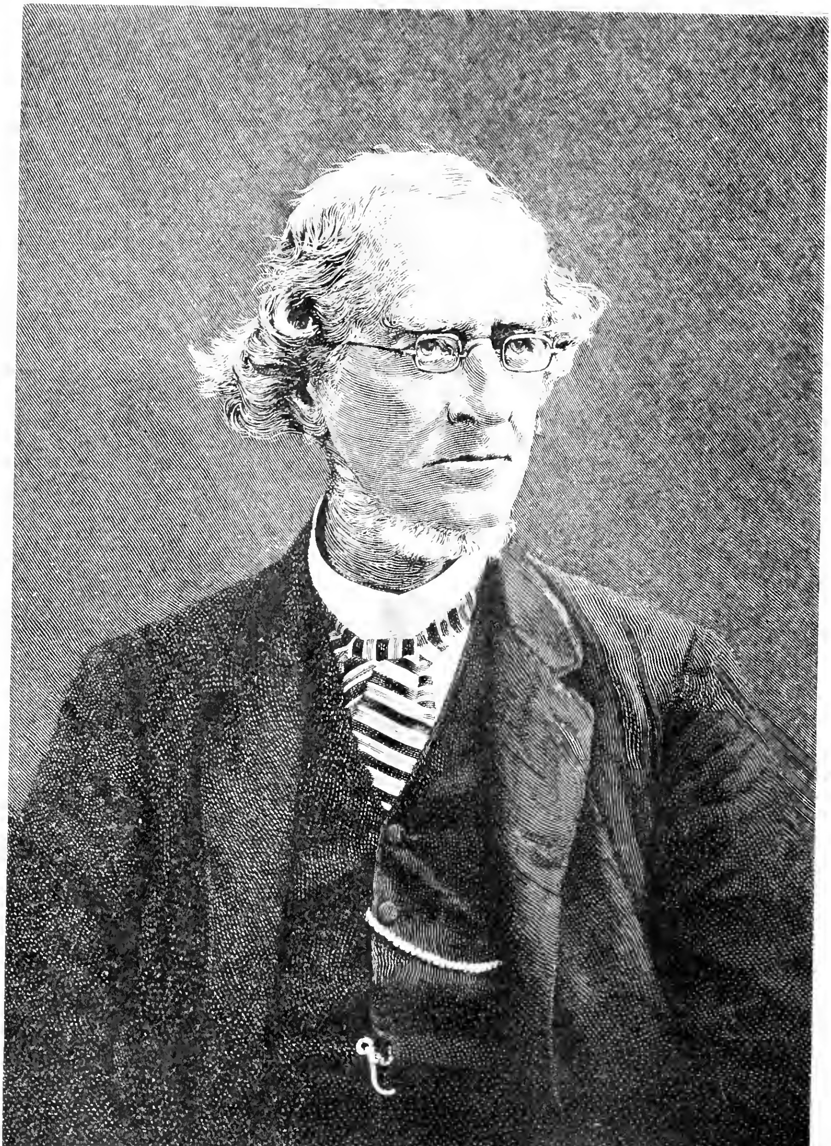

JAMES CURTIS BOOTH

THE

POPULAR SCIENCE MONTHLY.

NOVEMBER, 1891.

UNIVERSITY EXTENSION.

By C. HANFORD HENDERSON.

ONE can scarcely fail to notice, in the intellectual life of America, how very rapidly a new thought sweeps across the continent. It travels with almost the speed of the whirlwind. The storm center is commonly Boston or New York or Philadelphia, and progress is toward the westward. At once the impulse is felt in Chicago and Denver and San Francisco. A new book, a new creed, or a new social ideal easily gains the popular ear. Like the Epicureans and Stoics, we delight to hear a new thing. It can not be said that this interest is always, or even generally, a profound or fruitful one. But it has at least this advantage, that it secures a speedy hearing for such ideas as are put in a form suitable for assimilation, and this alone is no inconsiderable gain.

The educational movement known as university extension is an admirable illustration of this national alertness and versatility. It is a movement capable of very definite presentation and of calling up equally definite mental images. As a result, it is now familiar in name at least to the majority of our people, and it has become so in a surprisingly short space of time. Returned travelers from England have whispered the name in private for several years past. Certain phases of the movement, such as the Toynbee Hall experiment of planting a colony of culture-loving men in the arid district of London, have for some time attracted attention on both sides of the water. But, as a distinct object of public interest and discussion in America, university extension is hardly two years old. It was not until the winter and spring of 1890 that the movement took rank as a question of the day. Outside of the larger and more interested cities, and possibly even within their borders, it may still be that the name of the move-

ment is more familiar than the idea for which it stands. It is the purpose, then, of the present article to state briefly—as becomes the importance of the subject—just what university extension is, somewhat of its history, and what claim it has for a permanent place in our intellectual life.

University extension has been well defined as a university education for the whole nation by an itinerant system connected with established institutions.

I confess that this sounds ideal, the proposition to educate the whole nation on higher lines, but that is precisely what the movement means. It means that any one in any place and at any time may take up advanced work in any department of human knowledge, and that qualified men stand ready and willing to help him. I feel that this is a most significant statement—so significant, indeed, that I may be pardoned for having said the same thing twice.

Our people as a whole are not intellectual and are not culture-loving. They are not given to what Emerson calls the reasonable service of thought. The majority of them are the servants of a much less noble master. It can not be expected, therefore, that so large an idea as forms the germ of university extension will meet with anything like immediate fruition. But it is a leaven which is well worth setting to work. The success of the movement is already well enough assured to demonstrate that in any community there are unsuspected numbers with a turn for higher education, and such an attitude of mind is apt to spread.

That is the end—to permeate the nation, the whole American people, with a taste for culture, and then to provide means for satisfying it. It is admitted that such a taste does not generally exist, but it is believed that it can be brought into being. No right-minded person, I think, will quarrel with this purpose, provided it can be shown that the proposed culture is genuine and not merely a veneer. The method, too, is correspondingly simple, and it seems to me quite adequate. It would be an impossible task to civilize all America at once. The Philistine element is much too strong for that. If the movement attempted such a task it might well be regarded as overly optimistic. But it is really as practical in its methods as a paper-box factory. It is going to attempt no regeneration in the lump, nor to force its wares where they are not wanted. What it is doing and going to do is simply this, to put the higher education within reach of those who care for it, and through these to stimulate others also to want the same thing. It might be well described as a missionary movement conducted on scientific principles.

Unharnessed to events, the scheme would read somewhat like a dream. It will be better, then, to give an account of it by telling

just what is being done in England, and what is being done and planned in America. It is well to begin with England, as being the older and better organized field. For my knowledge of the work there I am indebted to the conversations of friends who have attended the Oxford meetings, and to various reports and pamphlets, but most of all to an admirable little book on University Extension by Messrs. Mackinder and Sadler, which I would strongly commend to those who care to go further into the details and history of the English movement.

The work in England is divided among four organizations: the London Society for the Extension of University Teaching, the University of Cambridge, the University of Oxford, and Victoria University. While there may be some friendly rivalry as to which shall most abound in good works, it must not be thought that the organizations are in competition with one another. This would indeed be impossible in the case of the London Society, since its staff of lecturers includes those of both Cambridge and Oxford as well. The chief business of these central offices is to provide lecturers and to arrange courses. It must be constantly kept in mind that they are essentially teaching organizations and by no means mere lecture bureaus. It is true that university extension does not disdain to present knowledge in an attractive form. It makes an admitted effort to be entertaining. But this is only a means to an end. The main object is more serious, and consequently no course is ever given on miscellaneous topics. The unit consists of twelve weekly lectures on one approved subject. Such a course, therefore, covers three months and constitutes one term in the extension work. There are two a year, the fall and spring terms, separated by the Christmas holidays. Now that the movement is well established, a strong effort is being made to bring the studies into close educational sequence, and to have the work of succeeding terms continue what has been done previously. This is not always possible, for university extension studies are strictly elective and are never administered in prescribed amounts. But it represents the ideal and the more intelligent students clearly see the advantage of continuous and related work in place of indiscriminate browsing.

The central offices do not, however, assume the initiative. They are the agents and inspirers of the local centers. The movement generally starts in any given neighborhood by the interest and effort of one individual, or perhaps by the concerted action of several. The known friends of education in the locality are called upon, and the question of forming a center discussed. If the scheme seems feasible, a public meeting is arranged, great care being taken that it shall have no religious, political, or class

coloring. A speaker goes to them from one of the universities and explains the extension plan. If the impression produced be favorable and the question of ways and means do not hinder, the meeting results in the formation of a local center, and a permanent secretary and a board of managers are appointed. A subject is then chosen, and application made to one of the central offices for a lecturer. In many cases a particular lecturer is asked for, as the extension men are coming to have pretty widely known reputations, and the public naturally selects the most popular. The question of finance now comes in. The universities supply qualified lecturers, arrange courses, and hold examinations, but the expenses must be guaranteed by the local centers. The work does not pay for itself, but then no scheme for higher education ever does. The receipts from the sale of lecture tickets may generally be counted upon to meet half the expenses of the course. The rest must be provided for in some other way, commonly by subscriptions or by some larger benefaction. The university fee for the twelve lectures is about £45, and the local expenses will generally amount to about £20 more. This is for a single course. Where more than one course is taken, the proportionate expense is somewhat less.

In most cases the local center is an outgrowth from some library association or institute, and has already much of the needed machinery in the way of hall and books. The course is duly advertised and as strong a local interest enlisted as possible. The audience is made up of all classes, the more miscellaneous the better. The extension movement recognizes no class distinctions. It includes the gentry, mechanics, school-teachers, barristers, tradesmen—all, indeed, who will come. The work differs from that of the school, as it is primarily for the education of adults, and its methods have men and women in mind as the material.

And now the lecture begins. It lasts for about an hour, the lecturer endeavoring not so much to present the whole of the subject-matter of the evening as to give a distinct and helpful point of view from which his hearers may look at it for themselves. It seems to me that this is a most hopeful feature of the extension work, and one which brings it into direct line with the best of modern educational practice. It is the spirit of the new education to proceed always by appealing to the self-activity of the taught rather than simply to their capacity for receiving.

If the lecturer be skillful, the hour seems very short, for the feeling is abroad that here is a man thinking out loud and suggesting a whole lot of new thoughts which will make one distinctly the richer. It is a pleasant sensation, recalling the very cream of

bygone school days, and it shows itself in rows of flushed and grateful faces. An essential part of the lecture scheme is the printed syllabus, which is supplied at merely nominal price. This gives the systematic outline so needful to the student, yet so uninspiring in the lecture itself. In addition, the syllabus suggests a careful line of home reading in connection with each lecture. The lecturer also gives out one or more questions which are to be answered in writing and mailed to him some time before the next lecture. This home paper work is regarded as of the utmost importance, since it brings out the thought and originality of the student in a way that a simple lecture never could.

When the lecture is over, a class is formed of all those who care to enroll themselves as students, the other hearers withdrawing. The class lasts for about an hour, and also ranks above the lecture in educational importance. It is here that the personal intercourse between lecturer and students comes into play. It is, indeed, very much like the college seminar, and is as conversational in its tone as the bashfulness of the students will allow. The lecturer develops his points a little further, and explains any difficulties that may have arisen. He also uses the occasion to return the written exercises, and makes such criticisms and comments as he thinks best. Often, misapprehensions are to be corrected, and false views pointed out. Frequently there is the more agreeable task of reading some particularly good answer, and acknowledging the justness and perhaps the originality of a student's comment. In all cases no names are mentioned, and great care is taken not to wound the sensitiveness of any one. The sharper tools of irony and satire are always contraband.

One can readily see how much depends upon the personal qualities of the lecturer. He must, indeed, be a man out of a hundred, a well-qualified specialist, a brilliant speaker, and, above all, a man of much fine tact and discretion. Each organization has its regular staff of lecturers, who hold, in most cases, some other appointment, and give only a portion of their time to extension work. A few, such as Mr. R. G. Moulton, of Cambridge, and Rev. W. Hudson Shaw, of Oxford, devote themselves exclusively to the movement, and are its most successful exponents. But many promising young men have also been attracted to extension work—some through a genuine missionary interest in the spread of culture, and some for less disinterested motives. It is not, however, a proper field for experimentation. The work is difficult and needs men of known ability. The universities try to guard against failure by duly testing the capabilities of all young aspirants for lecture appointments. While it is most unfortunate when the wrong man does get into the work, the mischief is soon remedied, for his lack of success leaves him in a very short time

quite without engagements. In the lecture world there is a manifest survival of the fittest.

When the course ends there is a formal examination, open to all students who have attended a specified proportion of lectures and done the requisite home work. Certificates are awarded to the successful candidates, the results depending upon the term work as well as the examination. I have not myself much faith in academic labels, but these certificates have a certain value in stimulating the students to carry their work to completion.

Where university extension is still untried, half courses, of six lectures each, are sometimes given by way of experiment, but in this case no examinations are held and no certificates are awarded.

The statistics of the movement show that it is still increasing in popularity. All of the numerals which sum up its activity, attendance, lecturers, courses, have much more than doubled within the past five years. The figures of 1889–'90 show that nearly four hundred courses were given, and that these were attended by over forty thousand people. During the winter of 1890–'91 the attendance was over forty-five thousand. It is estimated that about ten per cent take the examinations. A number of new and interesting developments have attended this growth. Besides the regular fall and spring terms there are also summer meetings at both Oxford and Cambridge, which have been a most pronounced success. One can scarcely overestimate the advantage of even this brief residence at the universities themselves. It is no inconsiderable education simply to be in Oxford. The tastes which are thus encouraged make possible better things in the winter courses following. The Cambridge summer meeting is, on the whole, more scientific in its scope, and the numbers in attendance are consequently small, but are increasing as the opportunity becomes better known.

At Oxford the meetings have always been of a more popular character. The students are numbered by hundreds and even of late years by the thousand. The meetings only began in 1888, when the session lasted for but ten days. Yet there were nine hundred students present. Since then the sessions have lengthened and the attendance has likewise grown. For obvious reasons the students are largely drawn from the teaching class, the greater number being women. The opportunity of hearing such men as Max Müller brings even an increasing company of Americans to these summer meetings.

While the expense is kept as small as possible, the question of ways and means is too much for many of the poorer extension students, and scholarships are being founded to enable these to taste Oxford for at least a few weeks.

There are many other features of the English work, such as

students' associations, home reading circles, traveling libraries, and the like, which are doing much to extend its influence and render the movement permanent. One of these features, the scheme of affiliating students to the universities, deserves special mention. What the universities have been working for all along is the promotion of serious and continued study. Where this was out of the question, they did what they could, and tried to stimulate the neighborhood to something better. The work has now progressed far enough for them to offer a systematic course of study covering four years, and having a definite end in view. The students who take eight unit courses in related subjects approved by the management, and who do the home work and pass the examinations successfully, receive the title of S. A.—affiliated student—and have the privilege at any subsequent time of remitting one year's residence at Cambridge, and so completing their studies there in two years. In the majority of cases two years would be quite as prohibitory as three, since the students are no longer young, and are already pledged to some career in life. Yet affiliation is held to be a great good, for it brings system and continuity into extension work, and makes a closer and more vital bond between the universities and the people.

If we come now across the ocean to our own country we shall find, considering the newness of the movement here, a development of the university extension idea even more surprising than in England. It is a large tribute to the catholicity of this idea that it stands transplanting so admirably. The needs of the human spirit are much the same in all countries. What is deepest in us and best is essentially cosmopolitan. The extension scheme is distinctively English in its origin, yet it has needed surprisingly little adaptation to fit it to American conditions. Perhaps the chief differences in condition are geographical. Life is more concentrated in England than with us, and the main changes will have to be in deference to our magnificent distances.

In certain quarters the importation of a British idea is resented almost as warmly as if the article were a steel rail or a durable cloth. In others, again, it is said that we have had university extension in America for many years, and we are pointed to the lyceums of New England and to Chautauqua. These institutions have undoubtedly done admirable work, but they are not university extension, and it is no discredit to them to say so. I have no particular desire to represent the movement as unique. It would be seriously misrepresented, however, if the impression were allowed to become current that university extension is simply a duplication of educational machinery already in successful operation. It is not. It is a movement with a new end, the populari-

zation of higher university education, and it proceeds by a new method, the personal carrying of this teaching from the universities to the people. It is held to be more practical to take one man to a hundred students than to take a hundred students to one man. It is important to keep this object and this method free from any confusion with other organized work, for the usefulness of university extension lies in these lines, and not as a competitor with already established agencies of culture.

It is somewhat difficult to tell the story of university extension in America, for the idea sprang into action in a number of different localities. Without attempting to present the full history of the movement, it may be said that three distinct ideals have been advanced—the local plan, represented by Baltimore and Buffalo; the State plan, represented by New York; and the national plan, represented by Philadelphia.

The local plan is the oldest. Its first home seems to have been at Johns Hopkins University. Several years ago popular lecture courses were given by Dr. Adams and his colleagues at various centers in and around Baltimore, and as time went on the movement assumed more and more the form, and finally the name, of university extension. Several such courses were given during the winter and spring of 1888. The method was quite similar to that followed in England. The course consisted of twelve lectures, followed by the customary extension classes at their conclusion. The students were supplied with printed syllabi of each course. Dr. Adams also rendered a most important service to the movement by his interest in making it more generally known outside of his own city. Similar initiatory work was done by Dr. Bemis at Buffalo. In the fall of 1887 he gave a course of lectures on economics, which were quite in the extension spirit.

The State plan is, I believe, peculiar to New York. It would, indeed, be less possible elsewhere, since New York is the only State which has a department created and maintained by statute to "encourage and promote higher education." The movement has had the constant interest and support of the best element in both the city and State. The State Librarian, Mr. Melvil Dewey, has been particularly active in its promotion. According to this plan, the State assumes the direction of university extension, working by means of an established central office at Albany, and operating through existing institutions for higher education. The Legislature has recently granted an appropriation of ten thousand dollars for carrying on the enterprise. Already much good work has been done in the way of lecture courses and printed syllabi and text books.

The national plan has been a slower evolution. It is an out-

growth of the local society at Philadelphia. The history of this organization is sufficiently typical to warrant its statement in some detail, the more so as its aims are now national. The idea of university extension was not known to the city at large until the winter and spring of 1890. It aroused so much interest, however, that the public discussion of the question led to the formation of a society on the 1st of June. Dr. Pepper, the Provost of the University of Pennsylvania, became its first president, and Mr. George Henderson was chosen secretary. The society at once went to work in a most practical and business-like way. It was recognized that two things were wanted—more definite information in regard to what was being done in England, and also the interest and co-operation of educators connected with neighboring teaching bodies. Accordingly, the secretary was sent to Europe, and in the fall presented a report of what had been accomplished there. Further, a circular letter addressed to the available teachers of the locality assured the society of a sufficient staff of lecturers. These ends gained, the work of the society began last fall in earnest. The first local center was at Roxborough and was organized in connection with St. Timothy's Workingmen's Club and Institute, which was already provided with an excellent hall and well-selected library. The subject chosen was chemistry, the first lecture being given on November 3d. The formation of centers and the announcement of courses soon became epidemic. By spring it was a rare thing to find any one among the more thoughtful classes who had not attended at least one extension lecture.

In the one season forty-two courses were given, numbering about two hundred and fifty lectures. The total attendance was about 55,500, a result unparalleled even in England.

Numbers alone are a very bad standard for an educational movement, but figures such as these indicate at least a wealth of teachable material. The success has indeed been beyond the most sanguine expectation. The idea is, I believe, due to Dr. Pepper that so vast a movement as this should properly be a national interest, and without local bounds. In December, therefore, the society changed both its name and its purpose, and became the American Society for the Extension of University Teaching.

The work in England, it will be remembered, is divided among four organizations, and there are advocates of this separation as well as of unification. Here in America the movement is just beginning, and we are called upon to choose. It must not be understood that the three plans mentioned are in any way antagonistic or are meant to compete with one another. They are the natural products of the different conditions under which they

have grown up. The only question is as to which plan will best serve the cause of culture. There is much to be said for all of these ideals, but it seems to me that the balance is indisputably in favor of the national plan. Already the American Society has extended its operations outward from Philadelphia as a center for upward of one hundred and fifty miles, and its purpose is to reach from ocean to ocean. A large step toward nationalization has been taken in the West. The extension work in Colorado, centering about the University of Denver, and perhaps the immense work planned for Chicago, will become branches of the American Society. It is also hoped that association may be brought about with the New York work. By bringing all these movements into one organization there will be greater administrative economy and greater system in the educational results.

What has been already accomplished by the National Society makes entirely reasonable the large plans which it has in mind for the future. The acting president of the organization is now Prof. E. J. James, who has associated with him educators of foremost rank from all sections of the country. It is proposed to utilize every feature which experience in England has shown to be helpful. The success of the American Society is indeed largely due to the fact that it has done little useless experimenting. The first season is always critical, but the movement had the large advantage of the constant service and counsel of Mr. Moulton. His many years' experience in the English work made him invaluable here. During nearly the entire season he lectured afternoon and evening in Philadelphia and its suburbs as well as in other American cities. He will be followed winter after next by the Rev. Hudson Shaw.

Now that university extension is well launched in America, it is hoped to offer more thoroughly systematized courses of study than was possible during the first season. A journal known as University Extension has been established, and issued its first number in July. Summer meetings will also be arranged, preferably at different university towns throughout the country. It is further proposed to introduce the plan of affiliating students to the universities, or even to go further than this, and finally to offer full courses leading to university degrees.

A most important and indeed an integral part of the work will be in the line of encouraging home study, and a well-thought-out plan has already been adopted. This provides a systematic course for that vast number of solitary students who can neither attend a university nor even form an extension center, but who are well worthy of the attention of a society committed to the cause of general culture. As at present arranged the courses cover four years of seven months each, or twenty-eight months

of study in all, and are strictly along university lines. It is true that these students lose the large gain which comes from personal intercourse with the teacher, but they are in constant communication with him, and by his letters and printed notes he can be an immense help in the way of stimulating and directing. At the end of four years a regular examination will be held. Those who pass it successfully and whose progress during the course has been satisfactory will be awarded a certificate which it is the purpose of the society to make of recognized value.

It is, then, an almost realized dream that any one in any place whatsoever may have the advantage of university education. It is a mistaken idea altogether, and one that has robbed the race of much progress, that education ends when maturity begins. By that time one has only gathered a few of the materials of culture. A grown-up man or woman with a book in hand for the purpose of serious study is in too many American communities almost an anomaly. But we have now fallen, it is hoped, upon better days, and the education of men and women has become a national purpose.

When a rich man founds an institution, erects substantial buildings for its accommodation, and bestows his name upon it as well as his money, public attention is arrested, for there is something visible and tangible for comment to spend itself upon. But right here, in our very midst, there is growing up a university more vast, I am bound to believe, than any of these extensive benefactions, and one destined to make a more profound impression upon the intellectual life of America than has yet been made. It is a university whose strength lies in this, that its students are as miscellaneous as society itself; that it is bound to no creed, no class, no party, but is committed only to the service of truth—not truth as you or I see it, or as any particular body of men see it, but to that increasingly transparent vision of truth which comes to humanity as a whole. Nor is the purpose of this university defeated by distance and railroad fares. It is the guest of every man or woman who will make it welcome. Neither does it demand what so often can not be given, one's entire time. Its duties may be fulfilled at odd moments, at any time as well as at any place.

To carry out so vast a purpose as this is going to take a proportionate number of men. And to do it thoroughly, on the high plane which is promised, is going to take thoroughly equipped men. It is still an open question as to just how this need shall be supplied. All the lecturers so far, with the exception of Mr. Moulton and possibly one or two others, have been men holding positions in established institutions, and this has had its advantages. The men bring the experience and the disciplined spirit of

the class-room with them and teach as well as lecture. And the effect upon the men is good too. The human element in them grows, and this without loss of scholarship. But so large an undertaking as this can not obviously take second place in the consideration of its agents. As time goes on, the staff of lecturers will probably include an increasing number of men who give their entire time to extension work.

It might be well if a man could alternate between resident and itinerant duty. Perhaps this would save him from that intellectual stagnation which is one of the chief dangers of the professorial chair. At present it seems to me that our universities are too much the asylum of men who nurse rather than use their scholarship, or who give their best energy to original research and throw only an occasional crumb to those who are pleasantly called their students. In all but the largest institutions one man has generally to teach several branches of his subject. If he did both university and extension work, he might devote himself to one particular branch and get better results in both fields. Prof. Johnson used to say that he wished there might be a professor for each chemical element, and he would like to be Professor of Iridium. But this is a matter which may safely be left to experience.

Besides the men, money is needed. So far, the work of the society has been paid for by the annual membership dues of five dollars, while each local center has met the expense of its own courses. The lecturer's fee is always fifteen dollars a lecture. This is paid to the central office by the local center, the lecturer having no direct business relations with the people to whom he goes. The incidental expenses of the course, varying with the locality, are met by the local management. Extension work may thus be undertaken by any university which will devote a little of the time of its secretary to the purpose, and by any local center which can raise the fee for a course of six lectures, ninety dollars, and provide for incidentals. It will thus be seen that very little money is required to make the experiment of an extension course. In some instances the local centers have had a considerable balance at the end of the season. But this has been due to the fact that only popular subjects have been chosen. It has been the experience in England, and it will undoubtedly be the experience here, that the more systematic and satisfactory work will not pay for itself. Some outside revenue must be looked to.

In England, several plans have been tried and proposed. In some cases a fixed subscription, as with the American Society, supplies the needed funds. In others, associations are formed and shares offered for sale, while still others depend upon private munificence. But all these resources are transient, and place the

work much at the hazard of changing fortunes. A better financial basis is wanted. It has, therefore, been proposed to attempt to secure endowment, through personal benefactions, by the definite assignment of university funds, or through state aid.

Sooner or later the same problem must be met here in America. Sufficient funds have been forthcoming to start the movement and carry it through a highly successful season. That was the main thing. The good gained is now to be secured and extended. To do this it is very desirable that the revenues shall not be precarious. The present source of income, by subscriptions, will keep the movement alive, but it will not allow that more comprehensive policy which seems so desirable. Private endowment has already done something and will probably do more, as the opportunities for good become known.

The possibility of enlisting Government aid opens a larger question. University extension is a national movement which is intended to reach all classes and to promote the most vital interests of the nation. It has, then, as large a claim upon the national pocket-book as any interest which the Government can recognize. The States provide for primary and secondary education; the nation might well provide for the higher culture. It seems to me a possible and in many ways a highly desirable scheme that with the unification of university extension into one national society, and the division of the country into suitable districts, the work should assume a truly national character and should be brought into close relation with the Department of Education at Washington. The commissioner might have his representative in each extension district, and the local office thus organized would not only be the center of the extension work in the district, but it could also render material service in the collection of educational statistics, and in bringing the department into more vital touch with the schools of the country. In this way we should have a university coextensive with America, a truly national university, since it would include the entire people, and one which would be a much greater power for good than the elaborate institution which is dreamed of for the capital city.

It is a commonplace that the most vital interest of America is the education of her citizens, and that her greatest danger lies in the disintegrating force of ignorance within her own borders. But this largest interest, both in point of power and of danger, is given secondary place in the national councils. We have a Secretary of War, of the Navy, of the Treasury, and of such material interests, but we have no Secretary of Education. With the elevation of the commissioner to the place of a cabinet officer, the new portfolio would be well charged with power if it had linked to it the destiny of a work of such magnitude and promise as uni-

versity extension. We should then be committed as a people in very practice to what we now profess only in theory, to the enlightenment and elevation of the whole nation. There are doubtless difficulties and objections in the way of carrying out the suggestion here brought forward; but, when the evidence for and against is duly considered, I believe that the balance will be found much in favor of such a nationalization of the extension movement.

As I set down in formal order these statements concerning the achievements and potentialities of university extension, I feel again the deep enthusiasm which was aroused by a first acquaintance with that large idea for which the movement stands. The attempt to realize this idea has had mixed with it somewhat that was unworthy. There has been a manifest tendency to estimate its worth by the common American standard of numbers. That thousands should listen to a popular extension lecturer was counted success; and men have gone into the work for the admitted purpose of advertising themselves and their branches. But these are the accidents of the movement. Under them there is an essential principle, a working idea, which has in it immense promise.

As a people we greatly need the leaven of a higher purpose. The ideal of life most current has in it much that is sordid and mercenary. Here is an opportunity to present a more worthy ideal, to substitute for the popular self-assertion a spirit of greater teachableness. We have not yet reached a point where we can impose our ideas upon the world-spirit, however vaingloriously we may try. They are not worthy. They must needs be renovated and transformed before they deserve permanence. The greatest claim which the extension movement can have upon thoughtful people is that it is an organized crusade against that current Philistinism which devotes the social opportunity known as America to lower motives and ends than are worthy of it. It is a mistake to suppose for an instant that the public schools of the country will ever save us from the utterly commonplace, or to fancy that the higher education is an expensive luxury which we can quite as well do without. On the contrary, it is just as much a necessity as the elementary training. It is essential to have good foundations, but, if we all went to building cellars and stopped there, we should never have any cities. We need the higher education in America, and we need it in large measure, for we are a people with a large opportunity. And we need it particularly now, for the grave problems which press upon us for solution will demand a tolerance and large-mindedness which come only when the human spirit is well disciplined. We have here a great and busy people, but a people too unimaginative and too

unideal. We need the infusion of a spirit of culture into the national thought and life, if we are to realize the destiny which seems possible to us.

The preaching of Peter the Hermit aroused all Europe. The present occasion is less picturesque, but the crusade which it preaches stands for interests much more vital than the recovery of Jerusalem.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

IX. THE MANUFACTURE OF STEEL. (*Concluded.*)

By WILLIAM F. DURFEE, Engineer.

WHILE the Englishmen, Bessemer and Parry, and the American, Martien, were experimenting in England, the germ which they were trying to develop into vigorous life had been discovered in America; for the evidence is unimpeachable that the late William Kelly had been for several years experimenting in the same direction as his English contemporaries. We are indebted to Mr. James M. Swank for securing a description of these experiments from Mr. Kelly himself; and the reader who desires to see the most complete account yet published of them will find it in Mr. Swank's Iron in all Ages.

Mr. Kelly and his brother bought the Eddyville Iron Works, in Kentucky, in 1846. Their product was pig metal and charcoal blooms. As a result of close study, the idea occurred to Mr. Kelly that in the refining process fuel would be unnecessary after the iron was melted, if powerful blasts of air were forced into the fluid metal, for the heat generated by the union of the oxygen of the air with the carbon of the metal would be sufficient to accomplish the refining. He first built a small blast-furnace, about twelve feet high, in which to test this idea. The furnace had two *tuyères*, one above the other, the upper one to melt the stock, and the lower to convey the blast into the metal. He began his experiments in October, 1847, but was interrupted by other work, and did not find time to take them up again till 1851. Finding that this furnace was not capable of melting the iron properly, he decided to separate his refining process from the melting operation, and take the metal already melted from the blast-furnace. In these experiments he was endeavoring to produce malleable iron.

"With this object in view," says Mr. Kelly, "I built a furnace, consisting of a square brick abutment, having a circular chamber inside, the bottom of which was concave like a molder's ladle. In the bottom was fixed a circular tile of fire-clay, perforated for

tuyères. Under this tile was an air-chamber, connected by pipes with the blowing-engine. This is substantially the plan now used in the Bessemer converter. The first trial of this furnace was very satisfactory. The iron was well refined and decarbonized—at least as well as by the finery fire. This fact was admitted by all the forgemen who examined it. The blowing was usually continued from five to ten minutes, whereas the finery fire required over an hour. Here was a great saving of time and fuel, as well as great encouragement to work the process out to perfection. I was not satisfied with making refined or run-out metal; my object was to make malleable iron. In attempting this I made, in the course of the following eighteen months, a variety of experiments. I built a suitable hot-blast oven; but, after a few trials, abandoned it, finding the cold blast preferable, for many reasons. After many trials of this furnace I found that I could make refined metal, suitable for the charcoal forge fire, without any difficulty, and, when the blast was continued for a longer period, the iron would occasionally be somewhat malleable. At one time, on trying the iron, to my great surprise, I found the iron would forge well, and it was pronounced as good as any charcoal forge iron. I had a piece of this iron forged into a bar four feet long and three eighths of an inch square. I kept this bar for exhibition, and was frequently asked for a small piece, which I readily gave, until it was reduced to a length of a few inches. This piece I have still in my possession. It is the first piece of malleable iron or steel ever made by the pneumatic process."

Although not giving up the idea of making malleable iron, Mr. Kelly now proceeded to utilize his invention so far as it was a complete success. He built a converter, five feet high and eighteen inches inside diameter, with the *tuyère* in the side. In this vessel he could refine fifteen hundred-weight of metal in from five to ten minutes, effecting a great saving in time and fuel. After a few days' trial, the old, troublesome "run-out" fires were entirely dispensed with. "My process," says Mr. Kelly, in the account above quoted, "was known to every iron-maker in the Cumberland River iron district as 'Kelly's air-boiling process.' The reason why I did not apply for a patent for it sooner than I did was that I flattered myself I would soon make it the successful process I at first endeavored to achieve—namely, a process for making malleable iron and steel. In 1857 I applied for a patent, as soon as I heard that other men were following the same line of experiments in England; and, although Mr. Bessemer was a few days before me in obtaining a patent, I was granted an interference, and the case was heard by the Commissioner of Patents, who decided that I was the first inventor of this process, now

known as the Bessemer process, and a patent was granted me over Mr. Bessemer."

There has been a feeling among metallurgists in both hemispheres that William Kelly's claims as an originator of a process similar in all its essential features to that invented by Henry Bessemer rest on a very unsubstantial foundation of experimental facts and experience. This impression is entirely erroneous, as was proved in the interference proceedings before the Commissioner of Patents, pending the issuance of a patent to Kelly (June 23, 1857); and again in 1870, when the question of granting an extension of Bessemer's patent (of November 11, 1856) was before the United States Patent Office, the commissioner refused to grant such extension, holding that the patent should not have been issued, as William Kelly was the prior inventor; and still again, when in 1871 William Kelly's patent was extended for seven years, it having been proved to the satisfaction of the commissioner that he had not been sufficiently remunerated for the invention; and yet again, by the fact of royalties having been regularly paid by the manufacturers of steel during the whole of the seven years for which Kelly's patent was extended, for the right to use his invention; and so unimpeachable was the evidence on which his claims were founded, that there was no attempt to set them aside during that time.*

The plain, straightforward statement of Mr. Kelly above quoted is an additional proof that he was no mere schemer or dreamer. It is evident that he had a definite end in view—the making of malleable iron—and had he possessed more capital and been situated where he could have availed himself of the best facilities, it is quite probable that he would have arrived at that end by the employment of methods and apparatus which would have left little to be desired; but, located in a small community (Eddyville had not five hundred inhabitants), in a part of the country remote from the best mechanical appliances and with limited means, it is remarkable that he carried his invention as far as he did before the heavy hand of bankruptcy crushed alike his ledgers and experiments.

As matters stood when Kelly's patent was issued, Bessemer had received a patent for the same invention, and at a later date a number of patents for apparatus the design of which was clearly very far in advance of anything accomplished by Kelly. Joseph G. Martien also had obtained a patent (February 24, 1857) for sub-

* In this connection it is proper to note that all the profits which the owners of the patents of Bessemer, Kelly, and Mushet ever received were earned and divided during the seven years covered by the extension of the patent of William Kelly; and had not that extension been granted, the parties who had put their money into the purchase of these patents would never have received one cent for their investment.

stantially the same claims as he had patented in England; but, so far as can be ascertained, he made no attempt to work his process, having become convinced that the inventions of Bessemer and Kelly were much more practical and really of an earlier date.*

On May 26, 1857, Robert F. Mushet, son of David Mushet, the famous Scotch metallurgist, obtained an American patent for the addition of a compound of iron, carbon, and manganese to cast iron in the process of making malleable iron and steel. Previous to this invention neither Bessemer nor Kelly had secured uniform product; and in fact Kelly had in only a few instances been able to make a malleable metal. Mushet's invention, therefore, became at once of controlling value as respects the new method of manufacturing steel.

Early in the year 1860 the attention of the late Zoheth Shearman Durfee † was attracted to the Bessemer process. Having become convinced of the great value of the process claimed alike by Bessemer and Kelly, he induced the late Captain E. B. Ward, of Detroit, to join him in obtaining control of Kelly's patents, and of the American patents of Bessemer's apparatus and process, and of Mushet's manganese mixture. In 1861 Mr. Durfee went to Europe and spent several months in studying the practice of making "Bessemer steel" in England, France, and Sweden. After his return he and Captain Ward, in May, 1863, organized "The Kelly Process Company," admitting Daniel J. Morrell, of Johnstown, Pa., and William M. Lyon and James Park, Jr., of Pittsburg, Pa., to an interest in the enterprise.‡ Although Mr. Kelly

* Under date of May 29, 1857, Martien wrote to Messrs. Munn & Co., the solicitors of William Kelly, a most generous letter, in which he abandons all claim to precedence in the invention. The following is an extract from this letter: "I have found and have been made perfectly satisfied, from the ample testimony laid before me in the case, that Mr. Kelly is honestly the first and original inventor of the said process of manufacturing iron without fuel. I find, moreover, that he has quietly been and is making improvements and advancing with his invention in a very praiseworthy manner, and of which the public will be put in possession in a short time."

† The late Z. S. Durfee was born in Fall River, Mass., on April 22, 1831, and died in Providence, R. I., June 8, 1880. He was a practical worker in iron and steel, and I claim that he was the first business man in America to fully appreciate the great value of the new process. He manifested the faith that was in him by a persistent effort to secure its adoption, and, had his views been supported by his business associates, the manufacture of steel by the pneumatic process would have been both a technical and commercial success in the United States many years earlier than it was.

‡ These gentlemen were selected because of their well-known business ability and their influential association with or ownership of some of the largest and best-appointed iron and steel works of the country, and it was confidently expected that they would take a lively interest in the new process by promptly employing it in the works with which they were identified, and that their example would be very generally followed by the larger iron and steel works of the United States. In this expectation Captain Ward and Z. S. Durfee were greatly disappointed, as neither Mr. Lyon nor Mr. Parke ever adopted the process in their works, and Mr. Morrell only succeeded in overcoming the objections of his associates

was not included in this company, a certain interest in any profits which it might make was guaranteed to him. Mr. Z. S. Durfee soon went to England again to arrange for the control of the rights of Bessemer and Mushet in America. He was unsuccessful in the former case, but obtained, October 24, 1864, control of the American patent for the use of *spiegeleisen*, as Mushet's triple compound was called, on terms which admitted Robert F. Mushet, Thomas D. Clare, and John N. Brown, of England, to membership in the company; and on the 6th of September, 1865, it was further enlarged by the admission of Charles P. Chouteau, James Harrison, and Felix Vallé, all of St. Louis, Mo.*

While Z. S. Durfee was on his first visit to Europe, the writer of these papers was invited by Captain Ward to design and erect an experimental plant to determine the possibility of making a good steel by the new process from Lake Superior iron. I accepted the invitation, and reached Detroit, Mich., on the morning of July 1, 1862. It was decided to construct a blowing engine, and a converting vessel large enough for producing steel on a commercial scale, with reference to their use in a works properly planned for economical administration and production should the experimental works justify such an enterprise. As to the rest of the plant, it was decided to construct it as cheaply and simply as would answer the purpose of the experimental works only, and it was further decided that the experimental plant was to be located adjacent to, and partly in, the building of the Eureka Furnace at Wyandotte, Mich., about ten miles from Detroit, where Captain Ward had extensive rolling-mills. The metal for the experiments would be taken direct from the blast-furnace, and the *spiegeleisen* was to be melted in crucibles.

As soon as this general scheme was fixed upon, I began my plans for carrying it out. But very little guidance was obtainable in this task. I had never seen any apparatus for the manufacture of steel by the method proposed, and the description of that used by Mr. Kelly convinced me that it was not suited for an experiment on so large a scale as was contemplated at Wyandotte. As it was confidently expected that Z. S. Durfee would be able to purchase Bessemer's American patents, it was thought only to be anticipating the acquisition of property rights to use his inventions. I accordingly procured copies of his patents.

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in the Cambria Iron Company (of which he was general manager) in such time as to enable him to commence making steel eight years after he was admitted as a member of "The Kelly Process Company."

* These gentlemen were owners and operators of large iron-works; and, although their admission as members of "The Kelly Process Company" was with the expectation that their example and influence would promote its interest, they did not erect steel-works, and the company was in no way strengthened by their connection with it.

which, together with the description contained in the first edition of Fairbairn's History of the Manufacture of Iron, embraced all

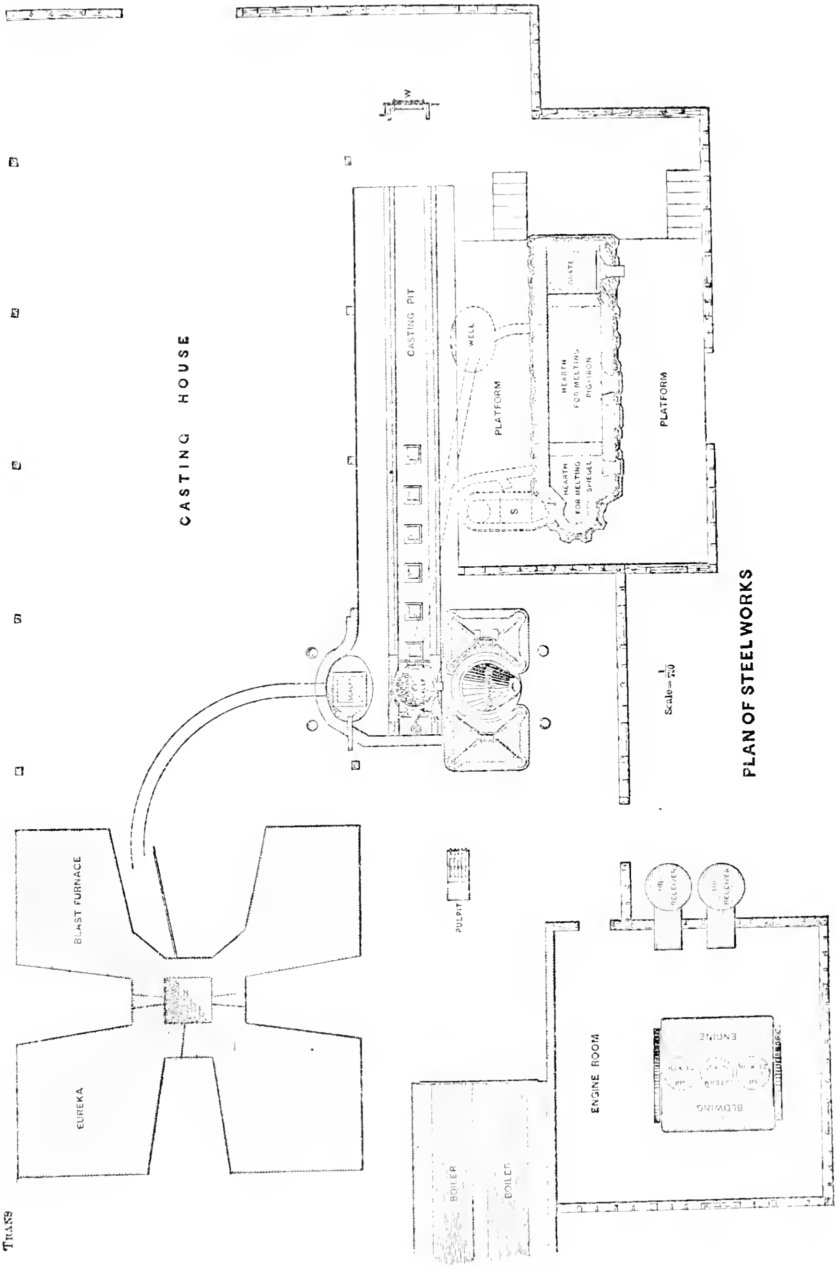

FIG. 60.—PLAN OF THE EXPERIMENTAL STEEL WORKS AT WYANDOTTE.

the information then accessible to me relative to the European practice of the new art.

Difficult as my task was, it was made almost insupportably burdensome by the outspoken opposition of nearly every influential person in Wyandotte. Nevertheless the work progressed, so that on the return of Z. S. Durfee from England in September, 1862, I was enabled to show him the "converter" nearly complete, and was greatly pleased to hear him say that it "looked

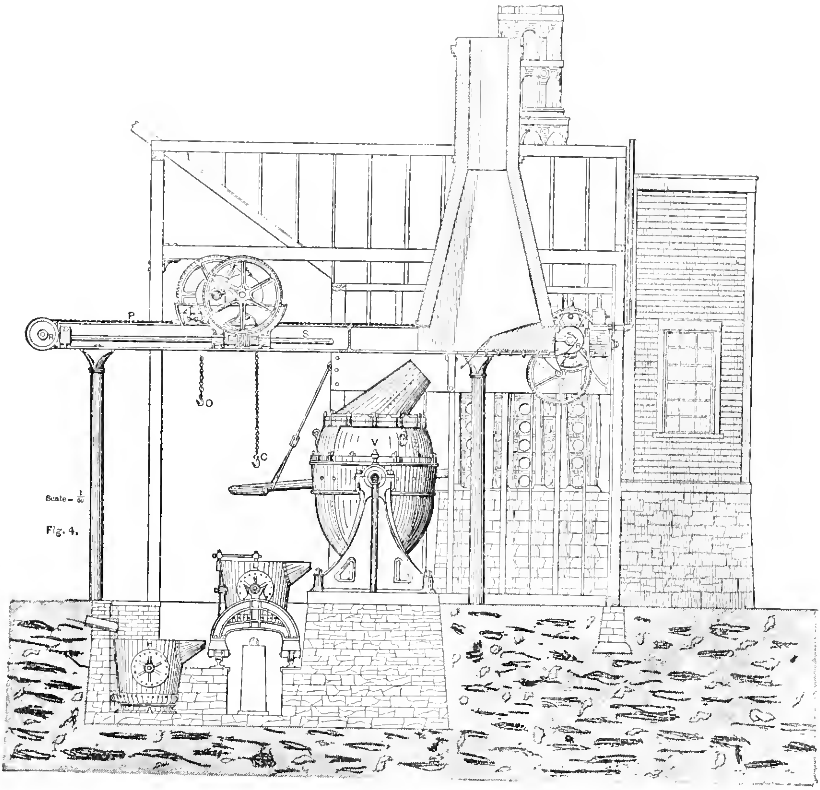

Fig. 61.—Cross-section of the Casting-house at Wyandotte.

very like converters that he had seen abroad." In the winter of 1862–'63 the blowing engine was commenced, but owing to various interruptions it was not completed till the spring of 1864.

The plan (Fig. 60) shows the general features of the arrangement adopted, save that over the casting-pit was a single-track traveling-hoist for handling ingots and molds. This hoist was operated by a winch located at *w*, the space allotted me in the casting-house not permitting the use of a crane of ordinary form.

The reverberatory furnace for melting pig iron was not included in my original programme; but in the summer of 1864, before the first conversion was made, it was decided to erect it in order that we could experiment with a variety of brands of pig

iron sent us by parties interested in the works. A hearth was made near the base of the chimney for melting *spiegel;* and subsequently a small furnace (located at S, Fig. 60) was constructed for melting *spiegel* when the metal for conversion was taken direct from the blast-furnace.*

Continuing our description of the works, Fig. 61 is a view of the machinery in the casting-house as it appeared to a person standing in the "pulpit" (see Fig. 60) and looking toward the converter, V. This converter is represented on a larger scale in sectional ele-

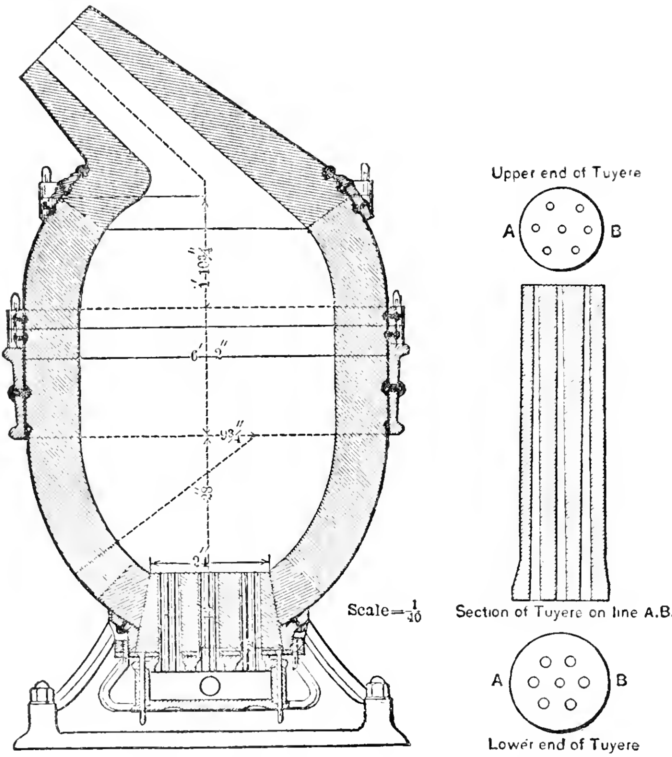

Fig. 62.—Section of the First American Steel Converter.

vation by Fig. 62; and to the right of this figure is seen a longitudinal section and end views of one of the seven *tuyères* used in the converter. This vessel was made with its upper part in two separate sections, and it was supported on its trunnions by two

* It was at these works, in the summer of 1865, that Z. S. Durfee made the first attempt to melt pig metal in a cupola for use in the converting vessel. At that time the practice abroad was to melt the metal in a reverberatory furnace. Owing to the small size of the cupola and its distance from the converting vessel, the experiment was not entirely successful; but Mr. Durfee did not abandon his belief in the usefulness of this process. I claim for him the origination of the idea of cupola melting, which has contributed so much to the rapidity and economy of production in the steel-works of the world.

tall cast-iron standards, and was turned by worm-gearing arranged to be driven either by hand or power. The engine which supplied the blast to the converter is represented in front elevation by Fig. 63; it was constructed from original working drawings made by the writer. It was intended to produce a pressure of blast of sixteen pounds per square inch, which was regarded as very heavy; in fact, I was informed, at the time of commencing the plans for this engine (the winter of 1862–'63), that the pressure used for blowing steel in England and Sweden was but eight pounds. I adopted the higher pressure with a view to shortening the time required for a "blow," but I soon became satisfied that this was a mistaken departure. I found myself in most excellent company, however, for, before my engine was finished, steel was blown in England with a blast pressure of twenty-five pounds, a practice which has continued until the present time. The engine had three upright cylinders of the same internal dimensions (twenty-four inches in diameter and thirty-six-inch stroke), the middle one being the steam cylinder and the outside ones the blowing cylinders.

Very soon after entering upon the study of the new process it became evident to me that an accurate knowledge of the chemical constituents of the metals and other materials employed was essential to its successful conduct; for, after we had found by working them that certain irons were, and others were not, suited to our purpose, analysis would in future enable us to determine whether any offered brand of iron was of suitable quality. These considerations, with others, determined the addition of a chemical laboratory to the works.*

As late as 1868 a large establishment for the manufacture of steel (in which over a million dollars was invested) commenced operations in western Pennsylvania, and at the end of one year it was abandoned and dismantled, the whole of the investment having been utterly lost in consequence of attempting to use material which an analysis costing not over fifty dollars would have shown to be absolutely unfit for the purpose intended. American "iron-masters" (so called) were not alone in their contempt for chemistry. I have in my possession a pamphlet published by a well-known firm of steel manufacturers in Sheffield, England, as late as 1870, for the purpose of attracting attention and trade, in which the following sentences occur: "The various articles on the

* At this time there was no such thing as a laboratory in connection with a steel-works in America: to the so-called "practical steel-makers" chemistry was an unknown and unappreciated science, and no sneer was too cynical for them to bestow upon those who advocated its employment. The laboratory at Wyandotte (which was derisively called "Durfee's 'pothecary-shop") was ultimately destroyed by the influence of incarnate malicious ignorance.

manufacture of cast steel in encyclopædias and other works are for the most part out of date or are written by scientific men having little or no practical acquaintance with the subject, and consequently are not of much value. . . . The steel manufacturers of Sheffield are not chemists. The application of chemistry to the manufacture of cast steel has not yet met with any success. The

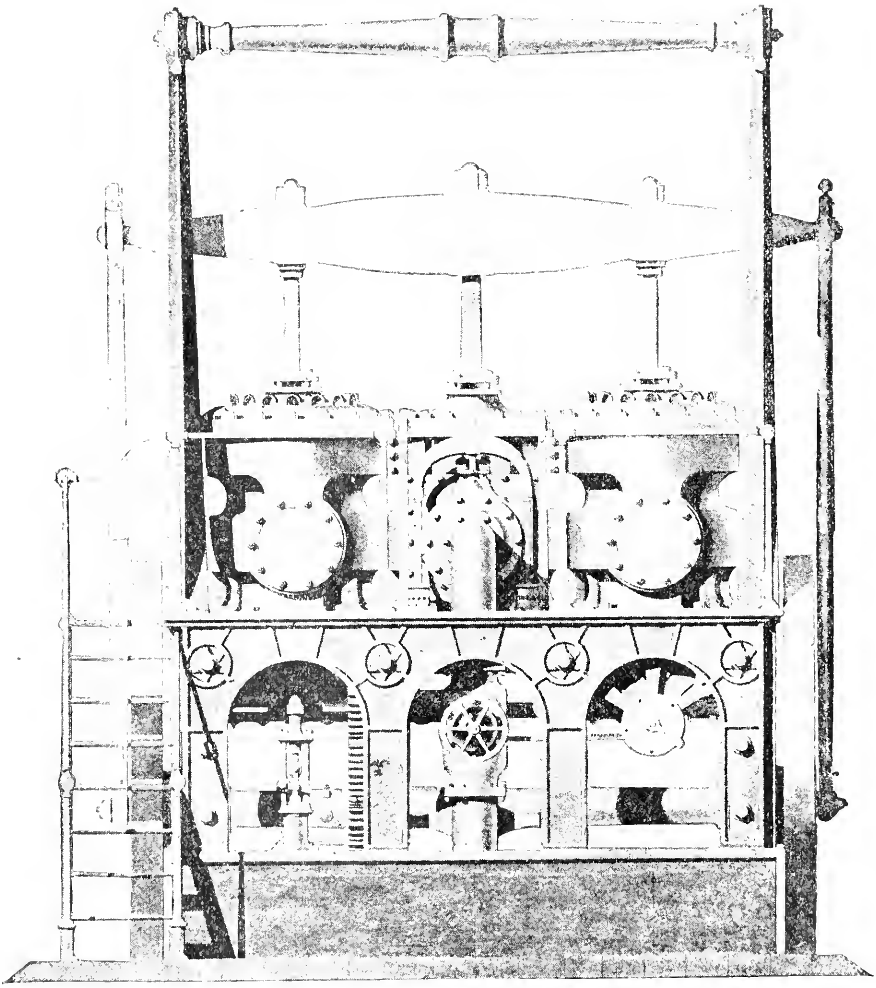

Fig. 63.—Blowing-Engine of the Wyandotte Works.

analysis of steel is a very difficult process. It has frequently been attempted in Sheffield, but never with any practical success." It is possible that the triumphs of chemistry during the past twenty years, as illustrated by the Thomas-Gilchrist and many other important improvements in metallurgical practice, may have convinced the worshipers of the ultra-practical—American

as well as English—that there are possibilities in chemistry not dreamed of in their philosophy.

The need of a laboratory was fully appreciated by Mr. Z. S. Durfee, and in the spring of 1863 he secured the services of Mr. Emil Schalk, a native of Germany, and a graduate of the École Centrale of Paris, as chemist. On his arrival in Detroit, at the request of Captain E. B. Ward, he accompanied an exploring party to northern Wisconsin. The result of this expedition was the discovery of a number of deposits of excellent iron ore.

On Mr. Schalk's return in October, 1863, he commenced some original investigations with a view to determine the influence of nitrogen upon steel, which promised to develop very interesting and valuable results; but, unfortunately, circumstances for which

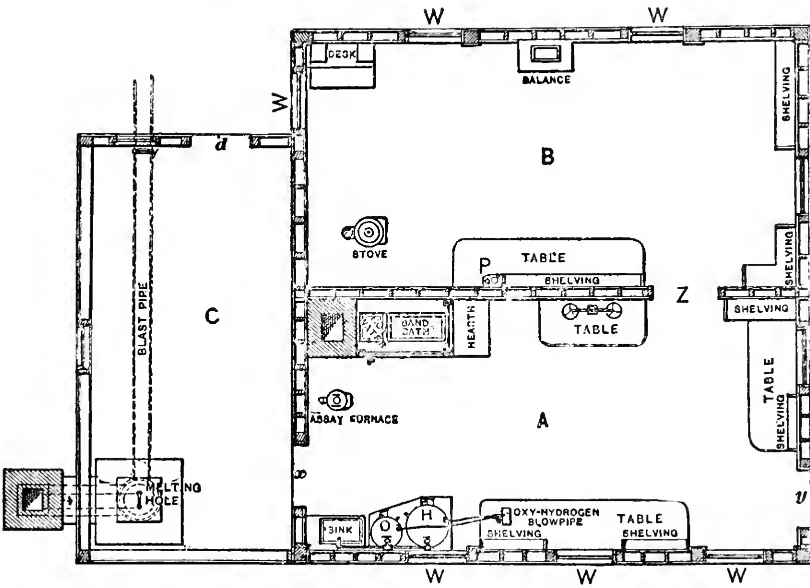

FIG. 64.—CHEMICAL LABORATORY AT WYANDOTTE.

he was in no way responsible caused his resignation in December, 1863, before they were completed. Of Mr. Schalk's abilities I had the highest estimation, and I very much regretted his departure from Wyandotte.

I will now describe the arrangement of the laboratory. The main building shown in the plan (Fig. 64) was about twenty-four feet square; it was divided by a partition into two rooms, A and B, of equal size, and each about eighteen feet high. At the rear of this building was a lean-to shed, C; *d* is an entrance to this shed from without; *x*, a door communicating with A; and *y* is the main entrance to the building. The room A was used for general analytical work, and was provided with furniture and

apparatus, as shown in the plan. The furnishing of the room B is also indicated.

The "melting-hole," in the corner of the lean-to shed C, was large enough to receive a pot which would hold seventy pounds of melted metal. Space will not permit a detailed description of the apparatus used in this laboratory,* but it would be regarded at the present day even, as thoroughly adequate for its purpose.

In the works at Wyandotte, on one of the early days of September, 1864, was produced, under the supervision of the writer of these papers, the first "Bessemer steel" † made in America.

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* This description of the Experimental Steel Works of Wyandotte is, owing to space limitations, much curtailed; but any interested reader will find in the Transactions of the American Society of Mechanical Engineers, vol. vi, p. 40, and in the Transactions of the American Institute of Mining Engineers, vol. xii, p. 223, papers by the writer hereof in which much more attention is given to details than is here permissible.

† I adopt here and elsewhere in this article the popular designation, for the reason that I believe it to be the just and proper one; for, while there is no room for a doubt that the late William Kelly anticipated Bessemer by several years in the discovery of the fundamental idea of the process, he did not carry it out to its ultimate possibility as a means for the manufacture of steel; and while there is no reason to believe that Bessemer ever heard of what Kelly was doing, it is pretty certain that had not Kelly noted the granting of a patent to Bessemer he would never (owing to his unfavorable location supplemented by pecuniary embarrassment) have been able to procure such attention from the iron trade of this country as would have insured him any reward for his invention. Furthermore, although in Kelly's stationary "converter," it would have been, under proper management, quite possible to make a satisfactory quality of steel (stationary "converters" were used in Sweden with success for many years), it was quite evident from the first that the highly original and ingenious apparatus invented by Bessemer (especially the tilting "converter," and the "casting ladle" having a tap-hole in its bottom) was far superior to anything proposed by Kelly. It is also quite evident that had not Mushet (or some one else) suggested the use of *spiegeleisen*, neither the ideas of Kelly nor Bessemer would have been of value except in the direction in which they were practically carried out by Kelly as a substitute for the refinery-fire, or in the special case of iron containing a notable quantity of manganese (as was the fact in those used at first in Sweden); but it is not at all probable that Kelly would have discovered what was necessary to perfect the process, as he had no knowledge of *spiegeleisen* (in 1857 no iron was known in the commerce of America by that name) and was not a chemist or an employer of chemists—but, judging from the fact that Bessemer availed himself of the aid of chemistry at an early day in his investigations, it is not at all improbable that he would have himself discovered the value of *spiegeleisen* had not Mushet anticipated him. I think all the facts warrant the naming the discovery The Bessemer-Kelly-Mushet Process; but as Bessemer, by his ingenuity, persistence in methodical endeavor, and business sagacity, is clearly entitled to the first place, and if the process is to bear but one name, the popular verdict of over thirty years is fully justifiable in calling it "The Bessemer Process."

While we are thus considering the relative merits of the chief actors in this metallurgical drama, it is but just that we should award due praise to Martien, the American, and Parry, the Englishman, for ideas of great originality, which, had they been followed out to their logical conclusion, must have developed similar results to those attained by Bessemer. These metallurgists evidently were standing, as it were, on the "delectable mountains" of discovery, and seeing dimly and afar some suggestions of the practical glories of the metallurgy of coming generations.

This event was a great disappointment to all those who had filled the air with predictions of failure, and they immediately turned their attention to a general depreciation of the results attained, and the persecution, with renewed vigor, of all who were responsible for them.

The first steel rails produced in America were rolled at the works of the Chicago Rolling-Mill Company (now a part of the Illinois Steel Company's plant, but then under the superintendency of O. W. Potter, Esq., late President of the Illinois Steel Company), at Chicago, on the 24th day of May, 1865. These rails were successfully rolled in a "twenty-one-inch three-high train," whose rolls were intended for rolling iron rails, and this fact is indubitable evidence of the excellent quality of the steel. There were three rails rolled on the 24th, and on the 25th three others.* Various experiments were tried to test the ductility and working qualities of the steel produced at Wyandotte; some of the early product was sent to Bridgewater, Mass., and there rolled into tack plate and cut into tacks, which were pronounced to be very much superior to any previously made of iron.† In order to test the welding qualities of the steel, John Bishop, the blacksmith of the works, made a tobacco-pipe, the size of an ordinary clay pipe, the bowl and stem of which were welded up of Wyandotte steel, and when perfectly polished there was no visible evidence of a weld. I have now two jackknives and a razor made from this steel; the knives are rather soft, but the razor was used regularly by my father for fifteen years, to his entire satisfaction.

When it had been shown that the pneumatic process was a qualitative success, instead of carrying out the original understanding and erecting new works arranged with especial reference to rapid and economical working, the parties in interest insisted that I should put a second converter into the experimental works, and attempt to make it a commercial success. Knowing that such an attempt could only result in utter failure, I resigned my position (June 1, 1865). Nevertheless, the proposed plan was carried out, and the works were permanently closed after about a year's unprofitable experience.

While the experimental works were being constructed at Wyandotte, the firm of Winslow, Griswold & Holley was formed for the purpose of purchasing Bessemer's American patents, and manufacturing steel under them. Negotiations with Bessemer were concluded in the spring of 1864, and an experimental plant at Troy, N. Y., was started on February 16, 1865.

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* These rails were laid in the track of the Chicago and Northwestern Railroad, and it is known that they carried the traffic over ten years, but unfortunately there is no record of the time when they were taken out and discarded.

† It is believed that these were the first tacks made of steel.

The purchase of the American patents of Bessemer by this firm at once challenged the right of the Kelly Process Company to employ the process invented by Kelly, and to the use of the apparatus invented by Bessemer; but, at the same time, the Kelly Process Company having purchased the Mushet patent for the use of *spiegeleisen*, was in a position to challenge the possibility of Messrs. Winslow, Griswold & Holley's making steel by the "Bessemer process" at all. The validity of the Bessemer patents for apparatus was, from the first, conceded by the Kelly Process Company, and arrangements were made, as soon as it was ascertained that they could not purchase the American patents of Bessemer, to dispense with the use of the machinery protected thereby; for they could avail themselves of that used by Kelly, which, although not nearly as convenient, was still, with some obvious improvements, capable of doing good work; or, rather, what the practice of the time called such.*

In view of these facts the Kelly Process Company was clearly the master of both the legal and commercial situation; and had it been governed by an enlightened business selfishness it would have profited by the advantageous position in which (thanks to the indefatigable labors of the late Z. S. Durfee, its secretary) it was placed; but in order to do this the law had to be invoked, and to the majority of the members of the Kelly Process Company the law was a terror! Lawyers must be paid! Experts would not testify gratuitously! Costs of court would accumulate! Judges were doubtful! Jurors were uncertain! And then, if victorious, what would they gain? And if defeated, utter ruin would overwhelm them! Never before or since has a party of reputable business men been so needlessly alarmed and so utterly oblivious of the first principles of a sound business policy. The various bugaboos and hobgoblins which their terrified imagination conjured up of the horrors of the life to come among courts, judges, lawyers, experts, witnesses, and obstinate jurors, in case they ventured to assert in a court their manifest right, at last drove them into making a proposition to Messrs. Winslow, Griswold & Holley looking to a combination of the interests of the two companies, and to their final acceptance of an agreement under which they surrendered rights which were of great value to Messrs. Winslow, Griswold & Holley, and obtained practically no rights in return save that of receiving but thirty per cent of the royalties earned by the combination, and that of leaving to Messrs. Winslow, Griswold & Holley the remaining seventy per cent.

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* In the early days of the Bessemer process, three "blows" in ten hours was thought to be a very creditable performance, but at the present time a works that could not make that number in an hour would be regarded as a fit subject for an inquest.

In the whole history of business affairs it would indeed be hard to find a more perfect illustration of "the tail waggling the dog" than this. It is only justice to the late Z. S. Durfee to say that he opposed this compromise and its unjust disposition of the rights of himself and associates with all the energy of which he was capable; and the fact that all the royalties the combination ever earned were received under the operation of an extension of the patent of William Kelly is quite sufficient to justify his business sagacity and foresight.

The experimental works erected by Messrs. Winslow, Griswold & Holley at Troy were used for nearly two years for the purpose for which they were designed, and their proprietors "extended every facility to blast-furnace owners in all parts of the country to have their irons tried for steel; . . . many were tried and most were found wanting."* It does not appear that any effort was made to compare the chemical composition of the irons that made good steel with that of the irons that would only make bad steel; and what was "good metal" seems to have been decided by actual treatment in the converter. Notwithstanding the numerous failures in the Troy works to make good steel out of poor iron (all tending to discredit the process), there were a sufficient number of successes and enough "good metal" discovered to encourage the firm in the erection of new works (called the five-ton plant) on a manufacturing scale. January 1, 1867, the late A. L. Holley left the Troy works to take charge of works at Harrisburg, for which he had furnished the plans.† For a short time after the departure of Mr. Holley the Troy works ‡ were under the charge of Mr. John C. Thompson. He was succeeded by Z. S. Durfee, who "built the forge and made some alterations both in plant and details of manufacture. Among other things, he adopted for the small or experimental plant the practice of melting the recarburizing metal in crucibles, and obtained most excellent results. . . . Mr. Durfee resigned his connection with the works in 1868, and Mr. Holley once more became the manager."

Up to January, 1871, the ingots produced in these works were

* Paper by R. W. Hunt, Trans. American Institute of Mining Engineers, vol. v, pp. 201–216.

† The phenomenal development of the "Bessemer process" in America during the fifteen years preceding the death of Mr. Holley in 1882 was largely due to his efforts. For a full account of the life and labors of the late Alexander L. Holley, C. E., LL. D., the reader is referred to a memorial volume published in 1884 by the American Institute of Mining Engineers, and to an able address delivered by James Dredge, Esq., Honorary Member of the American Society of Mechanical Engineers, in Chickering Hall, October 2, 1890, on the occasion of the unveiling of the Holley Memorial Statue, in Washington Park, New York.

‡ These works are still running, the company owning them now being known as the Troy Steel and Iron Company.

either hammered in the forge, or "bloomed" from nine-inch ingots, at the Rensselaer Rolling Mill in Troy, N. Y., or the Spuyten Duyvil Rail Mill at Spuyten Duyvil, N. Y., and then rolled into rails at these establishments, but on the above date Mr. Holley had a thirty-inch blooming mill ready to run. This mill was the joint invention of James Moore, William George, and A. L. Holley, and was built by James Moore, at his Bush Hill Iron Works, Philadelphia. The mill was provided with front and back lifting tables raised by hydraulic power. The tables carried loose rolls, on which the twelve-inch ingot (heavy enough to make two rail blooms) was placed and pushed into the rolls by men. Eight men were required to attend the mill. This mill proved to be a great advance over previous practice, but in the fall of 1872 improvements were added (invented by George Fritz, of Johnstown, Pa.) which reduced the force required at the mill to three men and a boy.

It is manifestly impossible in these pages to give in detail the history of the several Bessemer steel-works now in operation, and I have been thus particular in sketching at length the inception and development of the plants at Wyandotte, Mich., and Troy, N. Y., because they were the genesis of the Bessemer steel industry in America, and their history admirably illustrates the manifold obstacles which the promoters of all ultra-novel and radically revolutionary inventions have always had to encounter. I well remember the sneers which greeted my statement that the time would come "when a steel rail could be made cheaper than an iron one"; and now that time having arrived, it is no small compensating satisfaction to know that the faith delivered thirty years ago to the workers at Wyandotte and Troy has expanded with the years and by "*works*" has been made perfect: mountains have been removed,* and the metal of their ores now in our railways binds the nation together with bars of steel, along which glide shuttle-like, to and fro, the steam-propelled carriers of the commerce of a continent; interweaving it with the warp threads of agriculture and all arts, and producing a fabric of national prosperity and happiness that shall wear through the ages and continue to clothe this people while time endures.

A modern establishment for the manufacture of steel rails is vastly different from those ancient "plants" in which bar iron and iron rails were made forty years ago. Works that would turn out seventy tons per day then were thought to be remarkable both in size and in administration, but at the present time there

* The "Iron Mountain" of Missouri, which at one time was supposed to be inexhaustible, has had all its ore passed through the "furnace" and converted into iron and steel; and it is only a question of a few years when other great deposits now regarded as "mountains of ore" will share the same fate.

are many mills in the United States that can produce more than ten times as much in the same time. In the more perfectly ar-

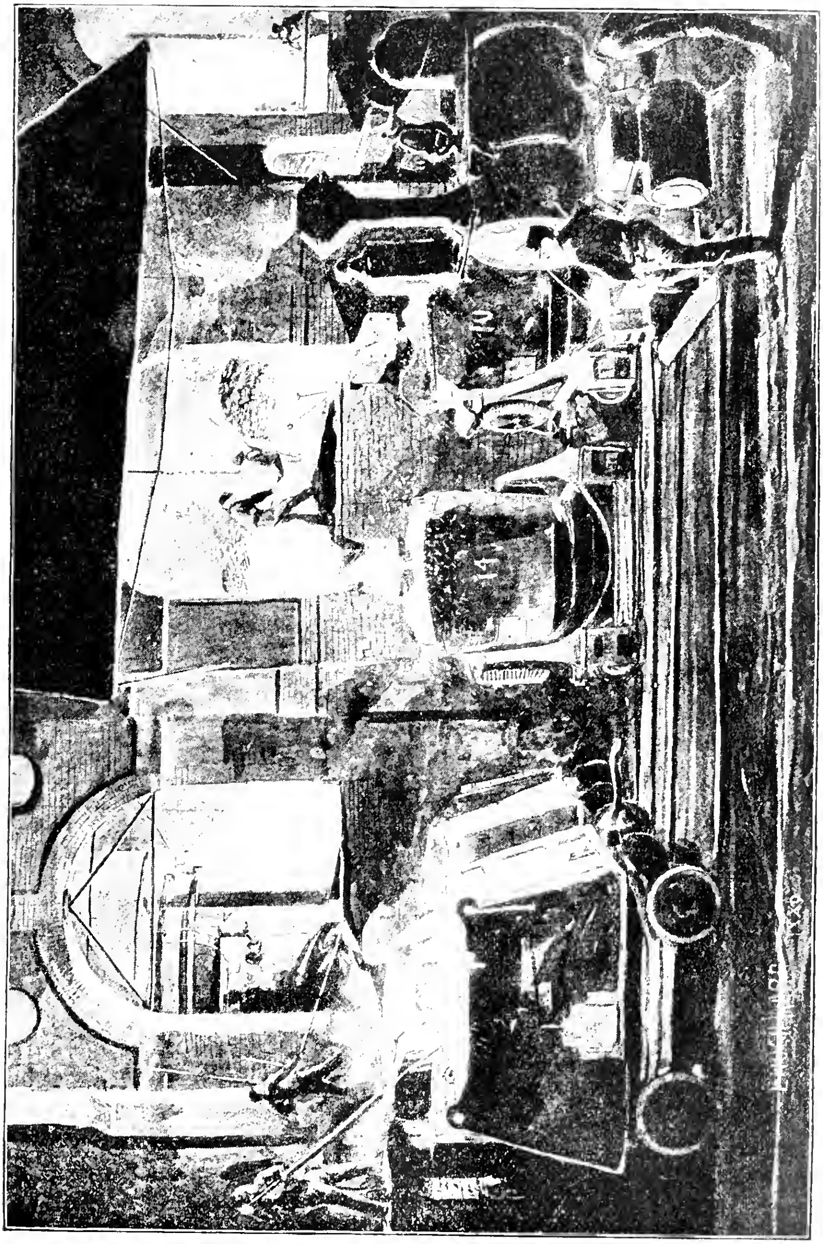

FIG. 65.—NIGHT SCENE OUTSIDE A CASTING-HOUSE.

ranged steel-works the molten metal is taken directly from the blast-furnace to the converter, and, after being "blown," is cast

into an ingot sufficiently heavy to make four rails; this ingot is taken from its mold while it is red-hot on its outside and still liquid internally, and put into a "soaking pit"* or a reheating furnace to prevent loss of heat, and as soon as possible, it is sent to the "blooming train" and rolled into a bloom; this is at once automatically conveyed to the "rail-train" and rolled into a continuous rail about one hundred and twenty-three feet in length, which is carried on rollers driven by power to the "cutting-off saws," which divide it into four rails of thirty feet in length, and the two extreme ends of the original rail, called "crop ends," are about eighteen inches long. The four rails, while still red-hot, are carried by machinery to the "cambering machine," and thence to the "hot-bed."† They are next taken to the "cold straightening presses," and any crookedness is removed by powerful pressure; the bolt-holes for "fish-plates" are then drilled in their ends, after which the rails are turned over to the "inspectors" representing the railway for which the rails are intended.

Fig. 65‡ is a very spirited night view of a scene outside the casting-house of one of the furnaces of the Illinois Steel Company. A portion of the furnace itself and one of its supporting columns are seen through the left-hand arch. In the left foreground are two "slag-buggies" being filled with liquid slag; on the right is a locomotive ready to pull them to the dump. In the center of the picture are two large "ladles" (numbered 14 and 10) capable of holding ten tons each of fluid metal, which is conveyed to them by the "runners" or "gutters" whose ends are seen projecting over the "ladles"; these gutters receive the molten metal direct from the "blast-furnace," and as soon as the "ladles" are filled they are drawn away by a locomotive which takes them up an inclined plane on to an iron bridge or platform, which extends across the converter-house in front of the converters. This bridge is plainly shown in Fig. 66, and a small locomotive is seen on the left-hand end of it.

Beyond this bridge, and between it and the back wall of the building, are the three converters, each intended for the conversion of ten tons of iron into steel at one operation. The left-hand

* This is a pit but little wider than the ingot, lined with fire-brick. The lining prevents the heat of the steel from radiating into space, and hence the internal heat of the ingot is diffused uniformly through its mass; and after being in the "pit" a certain time the ingot is apparently hotter than when it was put in; it is then taken out and rolled immediately. "The soaking-pit process," invented by John Gjers, is the most important improvement in the manufacture of steel that has been brought forward in the last eight years.

† This term is the reverse of descriptive. The "hot-bed" is a huge gridiron, on which the rails are placed to cool.

‡ I am under obligations to E. C. Potter, Esq., late Vice-President of the Illinois Steel Company for the very effective views from which this and the three following engravings have been reduced.

converter is shown "turned down," pouring its contents of liquid steel into a casting-ladle; the central converter is upright, and a

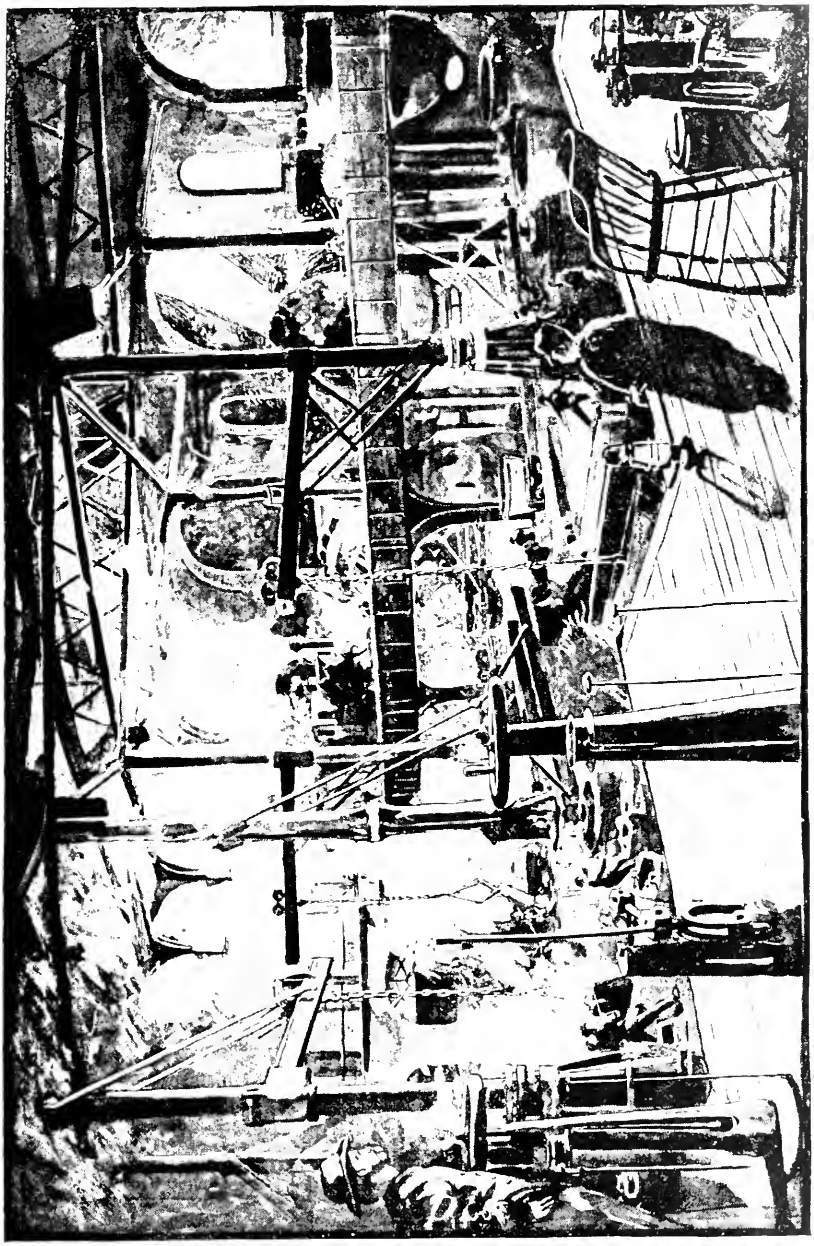

Fig. 66.—Interior of a Converting-house by Night.

dazzling white volcanic flame issues roaring from its mouth, discharging itself though the open archway in the wall of the build-

ing—a "blow" is evidently under full headway. The third converter is seen on the extreme right of the picture, with its mouth downward, its bottom having been removed for repairs.

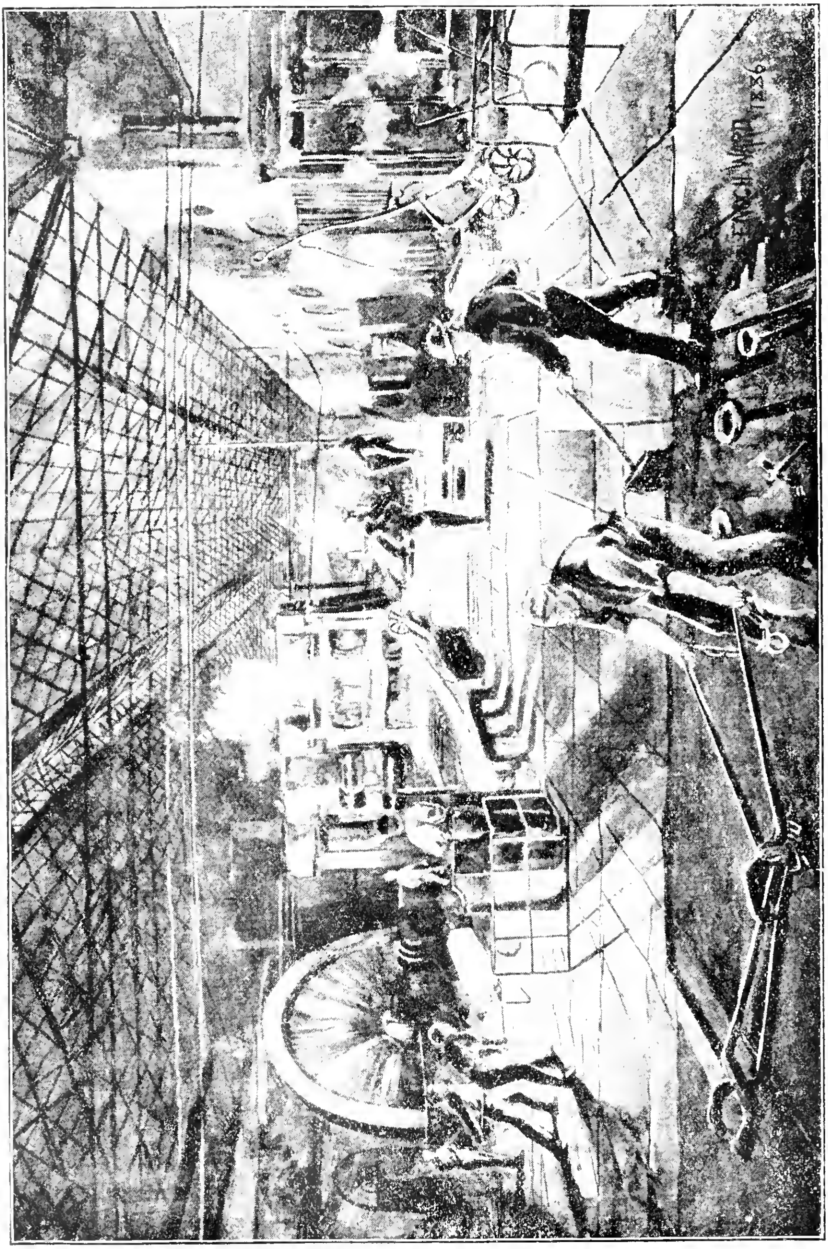

Fig. 67.—A Steel Blooming-mill.

In front of this bridge are a number of cranes, all operated hydraulically, but, unlike the ordinary "hydraulic press," whose

movement is usually very slow, these cranes are very rapid in their action, more so than any other form of crane; were this not the fact, it would be impossible to handle the vast quantity of hot materials—"ingots," and their "molds"—that must be disposed of with great promptness in a modern steel-works. These cranes are veritable giant arms, lifting and conveying with a tireless strength, insensible alike to heat and weight, such masses of steel as have only come to the knowledge of man since the invention of the Bessemer process.

The various operations of the "converting-house," embracing the turning of the converter, the regulation of the blast, and the movement of the cranes, are all directed and controlled by means of proper "hand-gear" located upon the platform called "the pulpit" represented in the foreground of the picture.

The general aspect of the interior of a converting-house at night is at once startling and grandly impressive. Here heat, flame, and liquid metal are ever present; locomotives whistle and puff, dragging with clatter and clang huge ladles of molten iron; the lurid light, flashing and flaming, that illuminates the scene, throws shadows so intensely black that they suggest the "black fire" of Milton, for in such a place it is impossible for a shadow to be cool; half-naked, muscular men, begrimed with sweat and dust, flit about; clouds of steam arise from attempts to cool in some degree the roasting earth of the floor; converters roar, vibrate, and vomit flames mingled with splashes of metal from their white-hot throats; at intervals the scorching air is filled with a rain of coruscating burning iron; ingot molds lift mouths parched with a thirst that can only be appeased for a short time by streams of liquid steel that run gurgling into them: the stalwart cranes rise, swing, and fall, loading scores of tons of red-hot steel upon cars of iron: all these conditions and circumstances combine to make an igneous total more suggestive of the realms of Pluto than any other in the whole range of the metallurgic arts.

The ingots of steel are taken from the "converting-house" as promptly as possible after they are cast, and carried on iron cars to the "blooming-mill" (Fig. 67), where they are put into gas-fired furnaces (the end of one is seen on the right of Fig. 67), where their heat is maintained, and thence they are taken to the "blooming train" and rolled into blooms. The steel-rail bloom is a rectangular bar of steel, long enough to produce four or even six rails.

In the cut (Fig. 67) on the left is seen a white-hot ingot of steel being carried on an iron "buggy" to the rolls of the blooming train, which occupies nearly the center of the picture. On the right of this train is seen a bloom about to pass through the

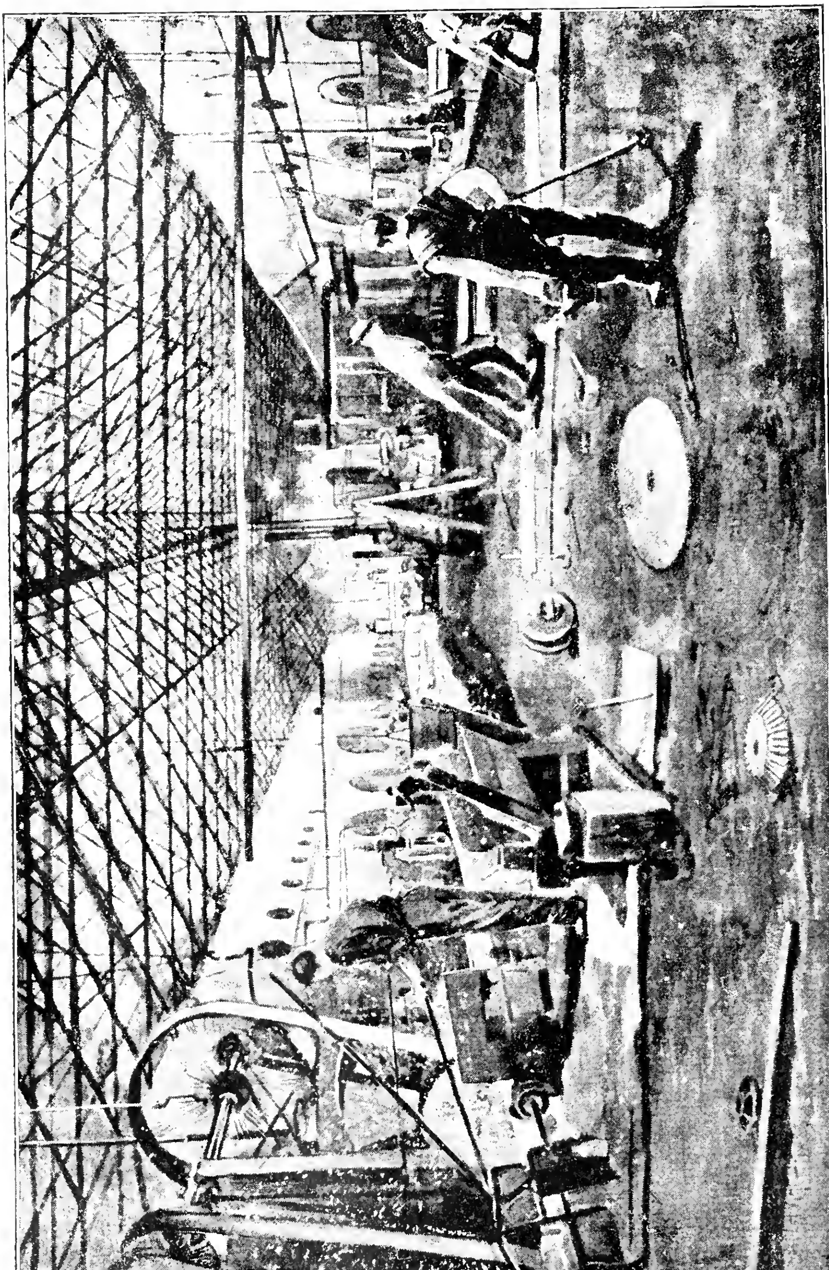

Fig. 68.—Part of Blooming-mill.

"finishing groove." The blooming train has a heavy fly-wheel driven by an engine of great power. In the farther part of the building is seen a cloud of steam which marks the location of the "rail train," to which the finished bloom is conveyed by mechanical means. Fig. 68 is a very spirited view of that portion of the rail-mill beyond the rail train (which is seen in the distance on the left of the picture). In the left foreground is shown one of the saws which cut the rails into lengths, and near the center of the picture a man is seen dragging out one of the "crop ends."

In all these views the small number of men employed in proportion to the work performed is very noticeable. By comparing one of these cuts with Fig. 47, the great difference between the practice of the present and that of thirty-six years ago in this respect is very evident. In 1855 a very large proportion of the work of a rolling-mill was performed by the strong right hands of a multitude of workmen; but in our day much more and heavier work is accomplished by powerful machinery—the crystallization of ideas emanating from the strong right head of some mechanical engineer, who had the ingenious courage to devise hands of iron, and muscles of steel, to do the required work of the present.

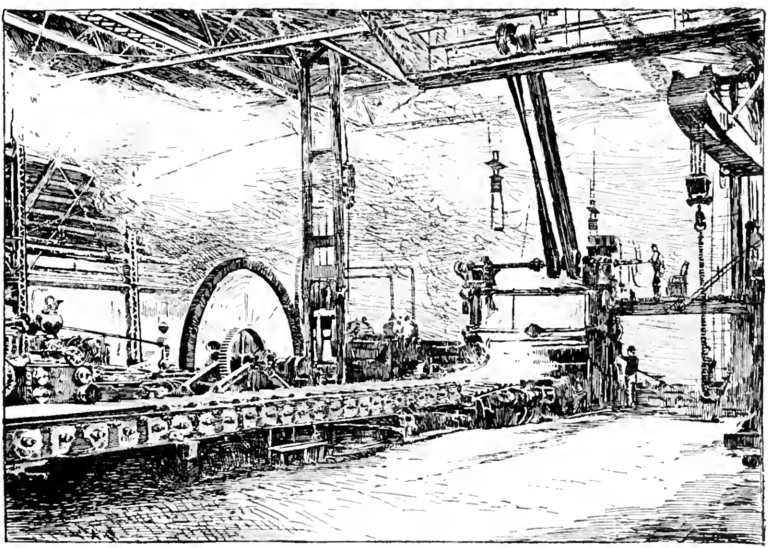

FIG. 69.—VIEW OF PLATE-MILL.

Fig. 69 is a view of a plate-mill at the Homestead Steel Works (Carnegie, Phipps & Co.) near Pittsburgh, Pa. This mill is what is known as a "three-high plate-mill." The train of rolls is driven at the rate of fifty revolutions a minute. On the delivery side of these rolls is a roller table five feet in width and 363 feet long, the rollers being driven by power. This mill can roll plates

three inches thick and 115 inches wide, or sheets $\frac{3}{32}$ of an inch thick and 117 inches wide, and of course any intermediate dimensions of any length, and of a weight not exceeding six tons. This mill can turn out five thousand net tons per month.

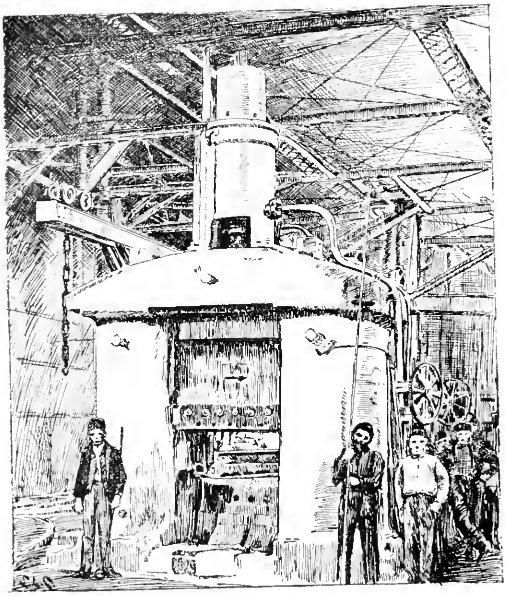

Fig. 70.—Hydraulic Shears.

Fig. 70 * is a view of the hydraulic shears in the "slabbing-mill" of the Homestead Steel Works.

The men in the picture will assist the mind of the reader in forming a correct idea of the magnitude of this ponderous piece of mechanism, whose purpose is to cut into the required lengths the "slabs" as they come from the "slabbing rolls." The lower knife is stationary, and the movement of the upper knife in a vertical plane is insured by guides on the "housings" of the machine. The upper knife is actuated by a water pressure of about three thousand tons, and the shears are capable of cutting a section 24″ × 48″ of hot metal. The "slabs" are taken to the plate-mill, reheated, and rolled to the required dimensions. The above description of some of the machinery in use in the Illinois Steel Works and in the Homestead Steel Works must serve for illustrating the ponderous character of the mechanism of a modern "steel plant," as it is plainly impossible in this paper to speak of details which would require a volume to adequately explain.

The "Bessemer process," as for many years conducted, could only deal successfully with iron which contained a very small quantity of phosphorus; this being the case, a very large proportion of the world's make of that metal was useless for the manufacture of steel; and therefore it was evident that any improvement by which such iron could be made available would have great value. This fact stimulated inventors to endeavor to dis-

* Figs. 69 and 70 are reduced from photogravure engravings illustrating a paper by W. Richards and J. A. Potter, descriptive of the Homestead Steel Works, which was published in vol. xv, No. 3, of the Proceedings of the United States Naval Institute.

cover some means by which pig iron high in phosphorus could be used in the "converter" or "open-hearth" furnace. Success was finally achieved in this by two English chemists, Sidney Gilchrist Thomas and Percy C. Gilchrist, of London, who secured patents for their invention November 22, 1877.* Their modification of the "Bessemer process" consists in the employment of *lime* as the chief constituent of the lining of the "converter" or "open-hearth furnace," and the action of this "basic lining" (hence the process is commonly called the "basic process") is to remove the phosphorus from the metal as a "phosphate of lime," in which condition it is found in the "slag" produced. There are a number of claimants, English, French, and American, for the discovery of the value of lime as a lining in "Bessemer converters," and "open-hearth furnaces" for the treatment of iron rich in phosphorus, who have caused so much litigation as to retard greatly the use of the "basic process" in this country; but, nevertheless, there were made during the year 1890 about ninety thousand tons of "basic steel" in the United States. The "basic process" is very largely employed in Europe, and fairly deserves recognition as the most important improvement in the metallurgy of steel that has been practically developed within the past dozen years.

In recent years there have been a number of alleged improvements in the manufacture of steel patented, most of them having no value.

It will be remembered that some of the early American experimenters, who "with great pains and cost found out and obtained a curious art by which to convert, change, or transmute common iron into steel" (in Connecticut, 1728 to 1750), succeeded in making "somewhat more than half a ton of steel" in four years. This seed of the steel industry on this continent has year by year and generation after generation increased and multiplied until for the year 1890 the production of steel of all kinds in the United States reached the enormous total of "4,277,071 gross tons," an amount larger than was produced in that year by any other country in the world.

Twenty-six years ago there were but two Bessemer converters in the United States, and it is not at all probable that in the year 1865 there were more than five hundred tons of "Bessemer steel" made therein; but this germ product has so wonderfully developed that in the year 1890 the total production of "Bessemer steel" in this country was 4,131,535 net tons, or 8,263 times the

* It is but just to explain that the "basic process" as conducted in Europe involves the use of the invention of Messrs. Thomas and Gilchrist, in connection with those of G. J. Snelus, of Workington, and Edward Riley, of London, whose inventions have contributed materially to its success.

tonnage of 1865. This enormous output was made in eighty-five "converters" owned by forty steel-works, which were distributed in eight States, viz., Massachusetts, New York, Pennsylvania, West Virginia, Ohio, Illinois, Michigan, and Colorado.

In 1772 the American manufacturers' price for steel was equal to $186.66 per gross ton. Steel of better quality can be purchased of the American manufacturer of to-day for thirty dollars per gross ton, a decline of eighty-four per cent in one hundred and nineteen years.

Twenty-seven years have elapsed since the first Bessemer steel was made in America, and that time, improved by the labors of skillful men from among our engineers, metallurgists, and chemists, has wrought wondrous changes in the construction and management of our furnaces, steel-works, and rolling-mills. To-day the tendency of all metallurgical manufacturing enterprises is toward concentration, not only in commercial and administrative affairs, but in their machinery as well. Giant engines, ponderous roll-trains, colossal hammers, crushing forging-presses, stalwart cranes, furnaces whose "fervent heat" destroys all doubt of the possibility of the fusion of worlds, ore piles rivaling mountains in magnitude; enormous stores of coal, suggesting yet more enormous mines; a vast entanglement of railways to all parts of the works; a water-supply sufficient for a town; miles of subterranean pipes bringing gaseous fuel to the roaring mills—are but the common details of a modern establishment for the manufacture of steel. Practices once condemned as criminal extravagances are now regarded as essential economies; things once deemed impossible by men of little faith are but the familiar occurrences of to-day. Buildings, machinery, methods, have all been touched by the spirit of progress. Science has become better acquainted with art, and art has a better appreciation of science, and their united forces are marching forever forward. Before their steady advance difficulties vanish, obstacles are surmounted, and seeming impossibilities are overcome; sound principles are established in place of empiricisms, and educated skill replaces laborious ignorance. Verily, "old things are passing away and all things are become new."

Evidence is given in the Rev. Thomas Parkinson's Yorkshire Legends and Traditions of the survival of the belief in fairies to a late date. An old man told the author a few years ago that his father, when young, had seen a dance of fairies, and that they were "of nearly all colors." A similar statement has been made to Mr. Parkinson's reviewer in the Athenæum, who suggests that such visions may be misinterpreted facts, not mere mental illusions. The birds called ruffs dance in the moonlight much after the fashion of the round dances of yore, and some of these dances may have been mistaken for those of fairies.

DO WE TEACH GEOLOGY?

By ROBERT T. HILL.

THE late Prof. Alexander Winchell, who did so much to popularize geology in this country, asked, "Shall we teach geology?" and our educational institutions have answered the question in the affirmative by expending liberal sums for the endowment of chairs in schools and colleges. The question now is, not shall we teach, but do we teach geology?

No modern science has been so vaguely understood and so indefinitely represented as that of geology. Our text-books, as a rule, are from fifteen to twenty years behind in the presentation of the vast results of the army of investigators in the field; and even among the working geologists there are wide differences in regard to fundamental definitions and theories. This great study, which has done so much for the advancement of knowledge and for industry, is still in a chaotic condition; and even its elementary definitions, as given in our text-books, are conflicting.

In the popular mind, in consequence of the mighty throes into which geological interpretation precipitated religious thought, the science is usually considered an irreligious inquiry into the history of the earth, or a useless study of curious fossils and pretty minerals To the practical investigator and student, however, geology has but one meaning, and that is, the science which treats of the structure of the earth and its changes.

A glance at the curricula of our universities will show that few of them teach the subject on this basis; they deal with the science either in the old-fashioned historical way, or devote their energies to some narrow branch—for example, paleontology, microscopic petrography, or economic mineralogy.

Geology can in many ways be compared with architecture, inasmuch as it is a scientific art, requiring a knowledge of many special arts and sciences. The architect must have a knowledge of mensuration, carpentry, masonry, materials, chemistry, physics, decoration, and other specialties pertaining to house-building. Likewise the geologist or student of earth-structure must have a knowledge of chemistry, physics, biology, mineralogy, mensuration, and all the sciences which are useful in interpreting this structure. Although we would never mistake a house-painter for an architect, we are overwhelmed by paleontologists, microscopists, and theologians who assume the title of geologists, and teach their narrow specialties under the broader name. An ethnologist who studies primitive dwellings is not an architect, yet how many astronomical data concerning pre-nebular hypotheses

and pre-geological speculations are taught as geology, as if to mystify the minds of students!

I well remember a young man who went from one of our great universities a few years ago with particular mention upon his diploma that he had attained special excellence in geology; in later years he found himself face to face with some of the greater problems of earth-structure, and slowly it dawned upon him that he had no conception of what the study really was. He knew the names of many fossils and minerals, could enumerate the historical sequence of the geologic time-epochs, but when required to report upon a new and strange region he found himself ignorant of the four necessary geologic rudiments—determination, definition, distribution, and delineation.

There is hardly a college in the land in which the study of the structure of the earth is not made subservient to the study of its history and composition, and in which the student does not learn to consider the extraordinary instead of the ordinary, by being taught to begin away back in Archæan time, and thence to trace the history of life-epochs. But the working geologist regards time-nomenclature as a secondary consideration, and the word Archæan means to him only a common dumping-ground for all older terrenes whose structure has not been differentiated.

Geology is not a science of the past, but a grand study of the present structure of the earth, its contour, composition, and readjustments. Geology has nothing to do with the origin or beginning of the globe—a field of inquiry purely astronomical—but takes the earth where astronomy leaves it, a completed mass of matter, and investigates its changes. Although Hutton a hundred years ago presented this thought in his saying that in the economy of Nature there is no trace of a beginning or evidence of an ending, still much of our geologic instruction is wasted on these subjects.

The cultural aspects of civilization are due to geologic structure, but in how many of our institutions are students taught to appreciate the topography or configuration of the earth's surface and its relation to structure, or to observe with inquiring eye the forms and contours of the landscape? The student usually learns the chemistry of certain nicely arranged hand specimens of hard rocks, and memorizes the names of leading fossils or the crystallography of minerals under the guise of economic geology. As a result, the study is supposed to be merely the study of hard rocks and curious fossils. Although the student knows these by sight, he can not trace a rock-sheet above the ground or below it, or see the great soft terrenes void of fossils and rocks which make up the larger area of our country, and can not appreciate the broader relations of structure to agriculture, hygiene, climate, and civili-

zation. Hence the great unfossiliferous terrenes are unknown; for example, the non-mountainous regions of the West and South, over which in places one may travel from the Rocky Mountains to the Gulf of Mexico without finding a fossil, a crystal, or a building-stone.

There is but one geological laboratory, and that is the great out-of-doors; and no student should learn a fossil or a mineral until he has first studied the landscape and is able to distinguish one stratum with its topographic form from another as strata, and not as fossil beds or chemical compounds. A field-glass and a quiet seat upon a commanding eminence, where the local surroundings can be studied, are worth to the beginner miles of traveling about with hammer and specimen-bag; and a thorough curiosity aroused as to why one hill is flat, another round, or one stream broad and sluggish while another is narrow and rapid, is more valuable than a cabinet of curios. An inquiry as to the origin of sediment in a river, whence it came, and what will become of it, will lead to a grander conception of earth-stripping and formation-making than the memorizing of all the specimens in a laboratory.

It is not my wish to discourage the study of paleontology or petrography, but is it not a serious error to teach these first and geology later? They are to geology as trigonometry is to mathematics, something that follows the fundamental arithmetic and algebra.

Some one has said that geology begins and ends with the rain-drop. If not literally true, the saying is worthy of consideration; and if the teacher begins with it, his students will soon be familiar with the grand facts of the erosion and distribution of earth-matter, and the origin of the rock-sheets that make the whole, and the life-history of our earth's great cycles can be read.

When we lay by our icthyosaurians and useless crystals for advanced study, and teach the ordinary and not the extraordinary features of the earth, geology will be appreciated, and every farmer, every builder of homes, every drinker of water, will learn that upon a knowledge of its simple laws his success depends.

To the high-school student a knowledge of the structure of the earth is as important as chemistry or foreign languages; but, until some simple text-book is written dealing with the subject on these lines, it is not to be expected that geology will be generally taught.

The principal achievement recorded in Dr. Hugo Zöller's recent explorations in New Guinea consists in the ascent of the Finisterre Mountains to a height of 8,700 feet, and the discovery of a still loftier range inland, which appeared to be covered with snow. Comparative vocabularies are given of forty-four languages, most of which were collected by the author himself or under his supervision.

DRESS AND ADORNMENT.

III. ORNAMENT.

By Prof. FREDERICK STARR.

THE savage loves finery. Anything bright and showy has for him remarkable attractiveness. Traders have often been blamed for their unequal trades with unsophisticated savages whereby they get a large return for articles of little value. Yet it must be admitted that often they could do little else. Truly useful and desirable articles are often passed by, and tawdry ornaments, beads, and tinsel are sought with avidity. The writer himself has frequently found, if cash payment is offered, that Indians demand preposterous prices for objects of ethnological interest; a few handfuls of beads or some yards of bright ribbon will bring about a quick and mutually satisfactory bargain. Early travelers found no people on some of the islands of the Pacific who would give anything for new kinds of fowls, domestic animals, or useful devices, but "a few red feathers would buy the whole island." "Necessity is always secondary to luxury" is a remark that will bear frequent quotation. Ornament is universal. The barbarian will go naked, unprotected, hungry, but he will have his ornaments.

Fig. 1.—American Indian with Necklace of Claws.

The beginnings of ornament lie far back in antiquity, but they may also be seen in savage life of to-day. The incentive that develops it is personal vanity—the desire for self-individualization. A man wishes to mark himself off from his neighbor by some external sign. If he kills a savage beast, what is more natural than that he should use its skin, its teeth, its claws, as a trophy? Wearing these, he is known as a mighty or successful hunter. Possibly the oldest decoration we know is a necklace from Duruthy Cavern, in France. Under a stone, apparently

fallen from the roof, was found part of the skeleton of a man. He had been crushed probably by the descending mass. Scattered about in such a way as to show that they had been strung together, were some forty large canine teeth of the cave bear, an animal now extinct. The teeth were perforated, and several were carved — not poorly — with animal and other designs. This necklace must have been originally a fine affair, and it is a good example of trophy-wearing. Naturally, what happens in hunting life may also occur in war. There, too, parts of enemies slain in battle may be worn as trophies. In the Louisade Archipelago, bracelets made of the jawbone and clavicle of foes killed in war were worn by warriors. Nearly all North American tribes formerly took scalps, which were worked up as fringes for garments, head-dresses, or other articles of ornamental dress. Trophies of the chase or of war were, we firmly believe, the first objects of decoration, and their only purpose was to render conspicuous the individuality of their wearer. Later the *idea of beauty in ornament* arose, and with it a host of objects which were *not* trophies came to be worn.

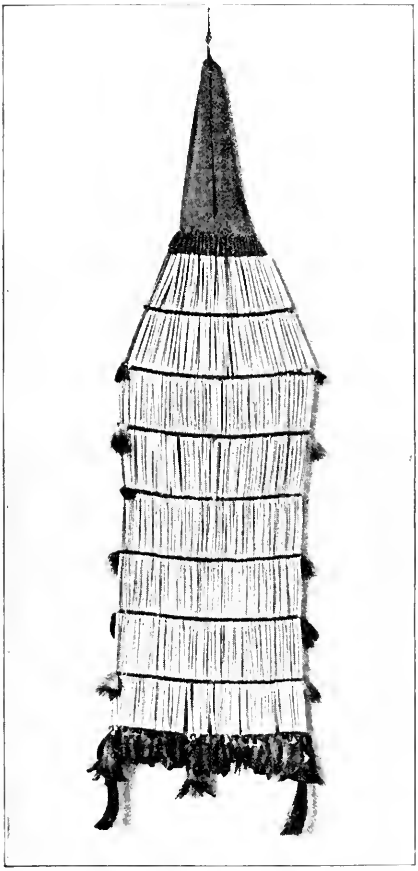

Fig. 2.—Ornamental Apron made of Toucan-bones. Mundurucu Indians, South America.

In examining the objects of ornament worn by savage, barbarous, and civilized tribes, we find a marvelous variety of materials and designs. We are amazed at the ingenuity displayed in making the most unpromising materials into things of beauty. Through this impulse of personal vanity—the wish to emphasize his individuality—man has been led to make many interesting discoveries and to develop many important arts. A dude is not a pleasant object; but, after all, the motive which has produced him has been of vast service in the world's progress. We will consider some instructive examples of ornament. The animal,

vegetable, and mineral kingdoms have all been laid under tribute for materials. Teeth, claws, shells, pearls, bone, hair, ivory, feathers, beans, seeds, grasses, leaves, fibers of all kinds, crystals, metals —these are but a few of the many substances that man has learned to use, more or less effectively, in self-adornment.

Necklaces are universal. Very simple are the garlands of red and yellow flowers, so popular throughout Polynesia. The whale-tooth necklaces of Samoa and the neighboring islands were really attractive, and were so highly valued that only kings and the most powerful chiefs could afford or dare to wear them. They consisted simply of the natural teeth perforated for stringing. They are now rare and seldom seen. Those at present used in the same district are lighter, more slender and artistic, but are made in England and sent out to the islands for trading. An interesting neck ornament was the *palaoa* of the Hawaiians. It consisted of a carved and polished piece of bone and ivory attached to an elaborately braided decoration of black hair. This ornament was worn only by chiefs of high rank and had some talismanic virtue. Among the necklaces from Australia are those consisting of kangaroo-teeth strung on thread, and the carefully made and really beautiful ones composed of cassowary feathers. Necklaces of trophies of dangerous hunting, analogous to that from Duruthy Cavern already mentioned, are made by Indian hunters from claws of the royal Bengal tiger. From the same materials the skillful goldsmiths of India make marvels of beautiful work. Such a one lies before me. The claws are perfectly cleaned and polished, mounted in gold settings, and strung on a chain of gold; pendent at the lower end is a pretty tiger and a charm, both of gold. Hundreds of years of time and generation of art development lie between the necklaces of Duruthy and Bengal! One of the most instructive lessons in culture history is shown by two South African necklaces described by Wood. The lesson is this: *in any art development, as new materials are gained, the*

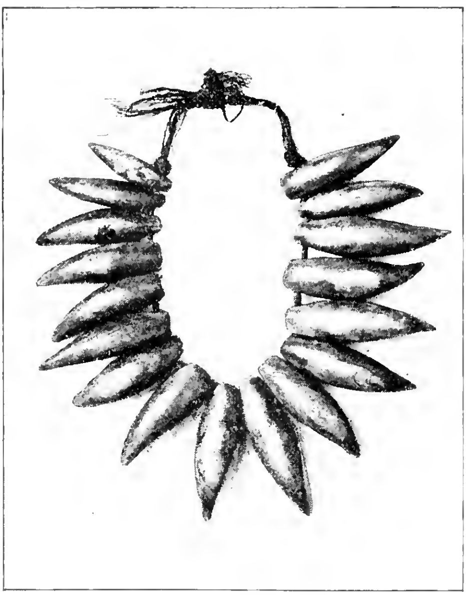

Fig. 3.—Necklace of Whale's Teeth. Samoa.

old types are copied in the new material. One of these necklaces consists of beads and teeth. Six or seven fine leather thongs are strung with black beads of small size; rows one and a half inch long being made, a single bead of larger size, and in color white spotted with blue, is added; then follows another inch and a half of black beads; then comes a cluster of leopards' teeth three to five in number; this arrangement is repeated. The other necklace copies this in general plan. Rows of white beads are followed by a brass tooth; then come ruby-red beads with white spots; then another brass tooth, white beads, etc. The necklace with real teeth is of an older type than the other, and it is interesting, even after metal has been introduced and the *ornamental* and not the *trophy* idea prevails, to see the old trophy pattern carried over into a new and artificial material. Patterns survive.

Arm-bands and bracelets occur in great variety, but little need be said of them. Two African forms only will detain us. Among the Kaffirs, and in the west of Africa as well, a plain ivory arm-ring, in a single piece, is in common use. Such are easily made. The tusk of the elephant is hollow save near the small end. Toward the larger end the ivory sheath is thin and irregular, but it thickens and becomes solid toward the tip. All that is necessary to make arm-bands is to remove the soft, vascular inner part and then to cut the ivory into cross-sections, two or three inches wide. The rings thus made vary, of course, in size. After being cut they are carefully polished. With such rings the whole arm from wrist to elbow is often covered. Schweinfurth describes a pretty ornament of metal rings—the *dagobar*—as in use among White Nile tribes. The individual rings are of iron and are narrow and neatly made. They are worn so closely together upon the arm as to make a continuous metal

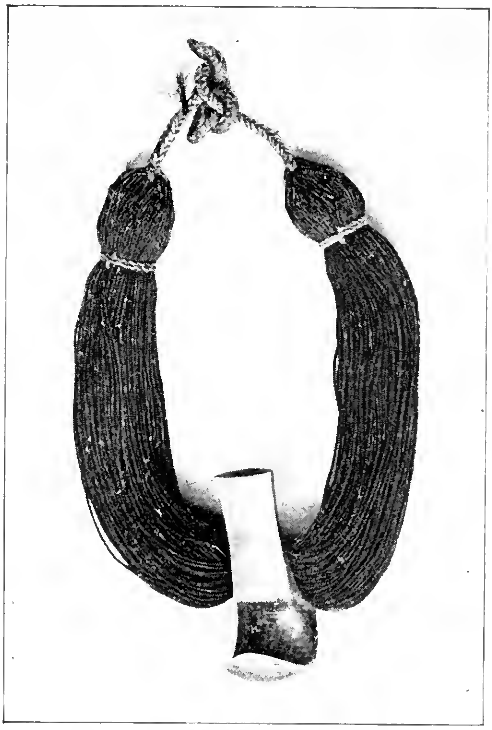

FIG. 4.—PALOA. Hawaiian Islands.

sheathing. Very curious are the arm-coils from Bouka Bay, New Guinea, which consist of one spiral strip of bark. *Ear-rings* are found in all times and among almost every people. They range in

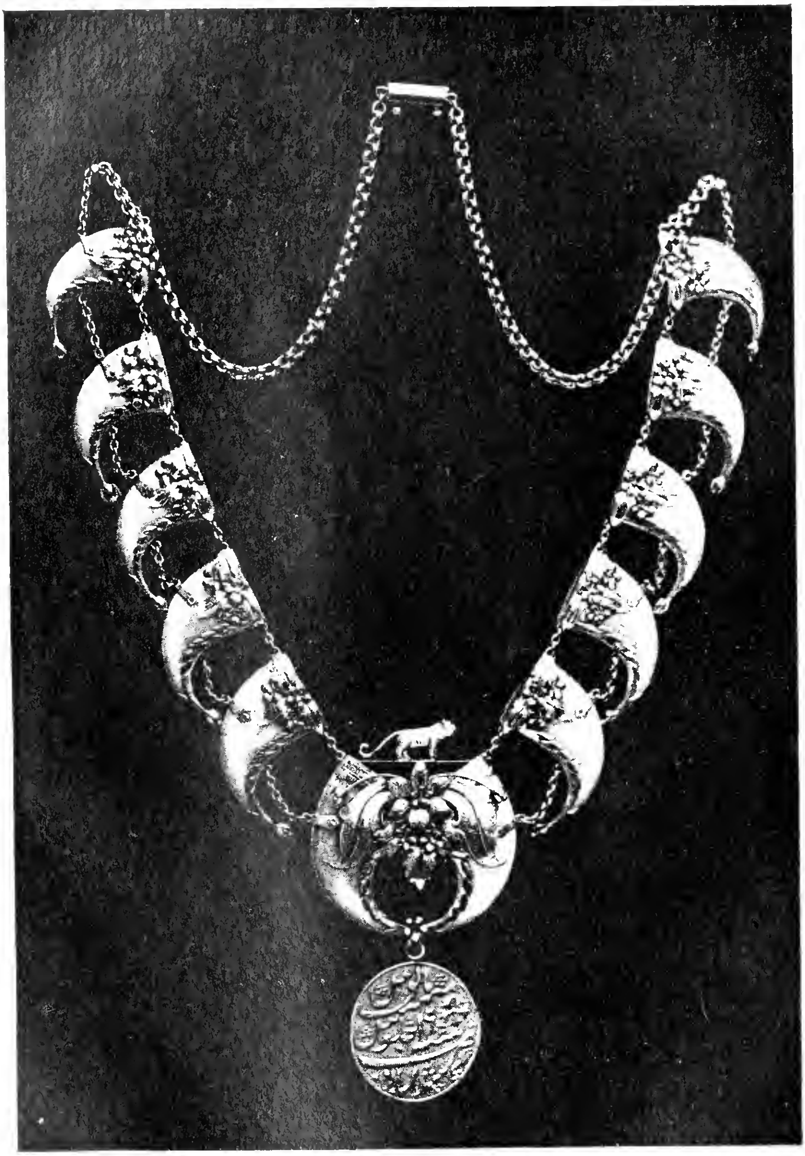

FIG. 5.—NECKLACE OF TIGER-CLAWS. India. (Miss Abbie M. White.)

size, material, and elegance from the brilliant solitaire in gold setting, worn by our ladies, to the bird-skins worn in the ears in New Zealand or the immense ornaments of shell with carved ivory in-

laying, from New Guinea. King Munza's sister begged lead bullets from Schweinfurth and hammered from them bright ear-rings. From New Zealand come very pretty ear-rings of green jade in the shape of sharks' teeth. Is it not certain that we here have another example of the law of copying an old form in a new material? Did the New Zealanders not wear *real* sharks' teeth, as some Alaskan and British Columbian tribes do now, before they made these more beautiful ones? *Waist-girdles* are interesting, not only in themselves, but also because of their influence upon dress development, already traced. In Australia they are often made of finely twisted human hair. Unique in material and really attractive in appearance are the Hottentot girdles made by stringing concave-convex disks of ostrich-egg shell. Such cords looked like a rope of ivory, and sometimes passed quite around the body. *Nose ornaments and labrets* were spoken of in the lecture on *Deformations,* and we care little to add to what is there said. Mr. Kunz recently showed us some interesting labrets made by the old Mexicans from jade and amethyst that show skillful work. These are all of the hat-shaped pattern, and the one of jade is very large. Were not some of the oldest ornaments known supposed to be *hair-pins,* we should hardly refer to these. From the lake dwellings of Switzerland we have a large number of these objects very neatly made, in a variety of large and ornamental patterns, from bronze. Vast quantities of bronze ornaments of all kinds—rings, arm-bands, wristlets, hair-pins, pendants, etc., have been found on these sites. *Feathers* are often worked up into wonderfully beautiful decorations. Some Upper Nile peoples use the "supple breast-feathers of the gray pelican, making them up into close perukes, which form excellent imitations of a luxuriant crop of gray hair." The head-dresses of bird-of-paradise feathers from the South Seas are beautiful in colors and graceful in form. The New Zealander made an elegant head-dress of pelican feathers, arranged in white bunches as wings on each side of the head, meeting above. The "war-bonnets" of eagle feathers, and the single, neatly wrapped and decorated feathers worn by American tribes, are well known. In this connection we may see how ornaments may indirectly en-

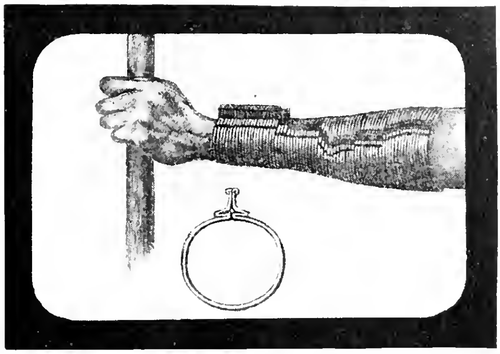

FIG. 6.—AFRICAN ARM ORNAMENT. The Dagobar.

courage art. Such delicate and perishable ornaments need especial protection from dust and injury. Receptacles of some sort must be provided, and usually such would themselves be decorated. In buying war feathers from the Sacs and Foxes, we found them kept in neatly made wooden boxes with slide covers. These boxes were usually carved and painted. The New Zealander for his choicest feathers made, with an infinity of toil and pains, elegant carved boxes of hard green jade.

Pendants have been used from an early date and are much prized by barbarous people. Akin to them are all sorts of breastplates, brooches, etc. Wood describes the *dibbi-dibbi* of the Australian. This is ordinarily fan-shaped and made of shell. It is also, however, at times crescentic and nearly as large as a cheese-plate. They are ornamented with drilled and engraved designs. Very much like them are the shell gorgets that have been found in the mounds of Tennessee, Georgia, and Missouri. They are among the finest specimens of art from the mounds. From two to five or six inches in diameter, these are disks, neatly carved from shell. The upper surface is concave and usually bears a carved design, often conventional but always well done—a spider, a rattlesnake, combinations of circles, spirals, and dots, a human figure, etc. While speaking of ornaments of this shape and size we may refer to the *sakahon* of the Sacs and Foxes. These are still made by the native jewelers from German silver. Those worn by men are pendent; those for women have a pin for attachment, forming what is called a *fibula*. These *sakahon* are ingeniously made and are worn in great numbers—one little girl's dance-waist bore two hundred of them. They are usually about an inch and a half in size. Among our Iowa Indians these pinning sakahon are only used by women, but Mrs. Harriet Maxwell Converse has a great number of very small ones, of silver, not more than a half-inch in diameter, which were formerly worn by the famous Iroquois orator Red Jacket. *Beads* are highly prized. The earliest were made of shell or stone, and later these were

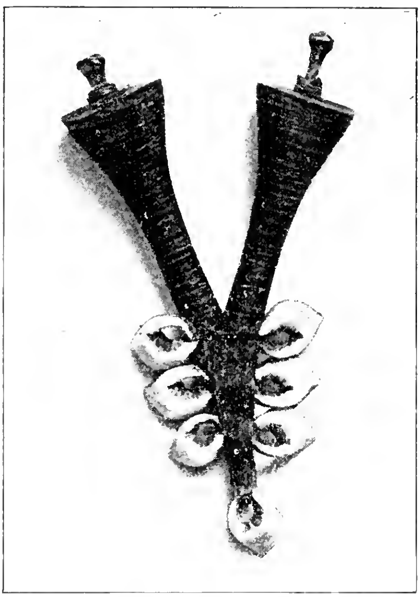

Fig. 7.—Nose Ornament. New Guinea.

copied in glass and metals. Glass beads have gone the world over. They have replaced many old materials, and have wrought great changes in many lines of aboriginal art work. But, there are beads and beads! Fashion changes as often among savages as with ourselves, and the bead so highly prized to-day may be worthless to-morrow. In Africa iron beads are always good, but glass beads fluctuate. One author tells us "they prefer as beads the '*mandyoor*'—long polyhedral prisms as large as a bean and as blue as lapis lazuli." But woe to the trader who took a stock of *mandyoor* there to-day! They might be a drug on the market. It may seem as if we have been too detailed in describing all these savage and barbaric decorations. We have simply aimed to show how varied in material and how diversified in form and use such ornaments may be. To show the profusion of ornament worn in some cases, and to illustrate the amount of discomfort which one will willingly endure for the sake of display, we quote a few descriptions:

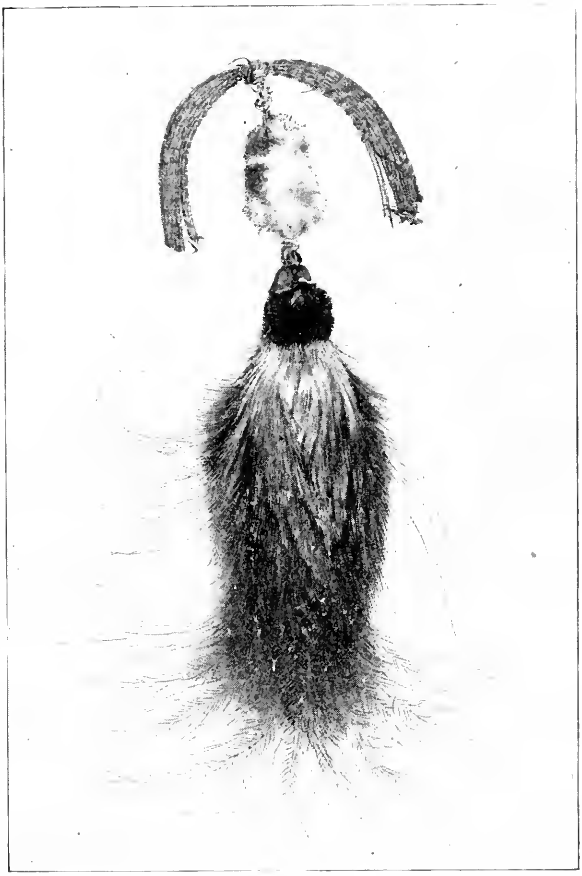

Fig. 8.—Head-dress of Bird-of-Paradise Feathers. South Sea Islands.

Livingstone describes the sister of chief Sebatuane as "wearing eighteen solid brass rings as thick as one's finger on each leg; three of copper under each knee; nineteen brass rings on the right arm; eight of brass and copper on the left arm, and a large ivory ring above each elbow. She had a heavy bead sash around her waist and a bead necklace. The weight of rings upon

her ankles was so great as to necessitate wrapping these with rags." Nubian women are particularly fond of silver, often wearing several watch-chains, three pairs of bracelets, bangles, ankle and leg ornaments, hair-pins, etc. That things were not much better in olden days is shown by Isaiah's remarks regarding the Jewesses: "Moreover the Lord saith, Because the daughters of Zion are haughty, and walk with stretched-forth necks and wanton eyes, walking and mincing as they go, and making a tinkling with their feet. . . . In that day the Lord will take away the bravery of their tinkling ornaments about their feet, and their cauls, and their round tires like the moon, the chains, and the bracelets, and the mufflers, the bonnets, and the ornaments of the legs, and the headbands, and the tablets and the ear-rings, the rings and nose jewels, the changeable suits of apparel and the mantles, and the wimples, and the crisping pins, the glasses, and the fine linen, and the hoods and the veils" (Isaiah, iii, 16–23). King Munza, whose state dress we spoke of in the last lecture, had an extensive wardrobe of ornaments. It occupied several apartments. In one room there was nothing but hats and feathers, especially those of the red parrot, arranged in great round tufts. In one hut were bundles of tails of civets, genets, patamochoeri, and giraffes, with skins and thousands of ornaments. There were also long strings of teeth of rare animals, one of more than one hundred lions' fangs. Surely it would seem that he had enough. An even more striking illustration of discomfort endured for the sake of display than that of Sebatuane's sister is the African belle who wore copper arm-rings which became so hot in the sun's rays that she was obliged to have an attendant with a watering-pot who would from time to time drench her to cool the metal.

Fig. 9.—Samoan Chief with Ornaments.

We have already said that the desire for ornament has led to much material progress. We believe that to it must be attributed the origin and development of metal-working. The evidence of this will be found in an examination of the metal-work of various primitive peoples. The bronze relics from the Swiss lakes are exceedingly various, but much the larger number of them are

ornaments—not weapons or instruments. So in Africa, although it is true that the natives make wonderful assegai-blades, we believe that they use both copper and iron far more for leg-bands, arm-rings, and other decorations, than for articles of utility. As due to the ornament-search of man, metal-working possesses a special interest for us, and its beginnings deserve consideration. The first steps are well shown in North America. Here not only the recent tribes but also the builders of the mounds used native copper from Lake Superior. This was not smelted, but was beaten into shape with hammers of stone. Thin sheets were also beaten out between two stones and used for covering wooden forms. Prof. Putnam has found some very interesting spool-shaped ear ornaments of copper in Ohio mounds. These are not easy to describe, but they are very ingeniously made. They consist of two convex-concave disks of beaten copper, from an inch to two inches in diameter, held together by a narrow column of rolled copper-sheet. Such have been found in other metals as well as in copper. In one *altar mound* of the Turner group were found two bushels of ornaments of stone, copper, mica, shells, teeth, pearls, etc., nearly all perforated for suspension. Several copper ornaments, viz., bracelets, beads, and ear ornaments, were coated with beaten silver; one copper pendant was covered with beaten gold; one ear ornament of copper was covered with meteoric iron, and half of one of these ornaments was composed entirely of this latter metal.

FIG. 10.—NUBIAN GIRL WITH NOSE ORNAMENT.

Just how smelting arose we do not know. It may have been an accidental discovery, but, if so, the accident must have occurred in different places and at different times, as there is good evidence that the art has independently originated at several centers. In western Europe bronze preceded iron. In the heart of Africa it seems as if there had been no bronze age before the iron age. The Africans are often remarkable smiths, producing an excellent quality of iron with a very primitive outfit. The bellows consist of two wooden or pottery bowls with bladder tops, or of leather sacks; from these run pipes made of wood or of antelope horns;

the tips of these are incased in a clay tube. Wooden sticks are fastened to the middle of the bladder covers or to the upper end of the skins. By working these handles up and down air is forced through the pipes into the tube and through the fire. This is built in a hole dug in the ground. The heated iron is worked hot between two stones used as anvil and hammer. Assegai-blades are made with this poor outfit of such excellence that they may be sharpened so as to be used as razors, and so pliable that they may be bent double and then straightened after reheating. This is iron working, not smelting. Schweinfurth describes how the Dyoor get the iron from the ore, and the process is practically the same throughout Africa. In March, just before seeding-time, he says, they go to the woods to smelt iron. In the shaded center of a very wooded spot they make groups of furnaces of clay. These are cones not more than four feet high, widening to a goblet shape. A cup-shaped cavity at the top communicates by a small throat with the main cavity of the furnace, which is filled

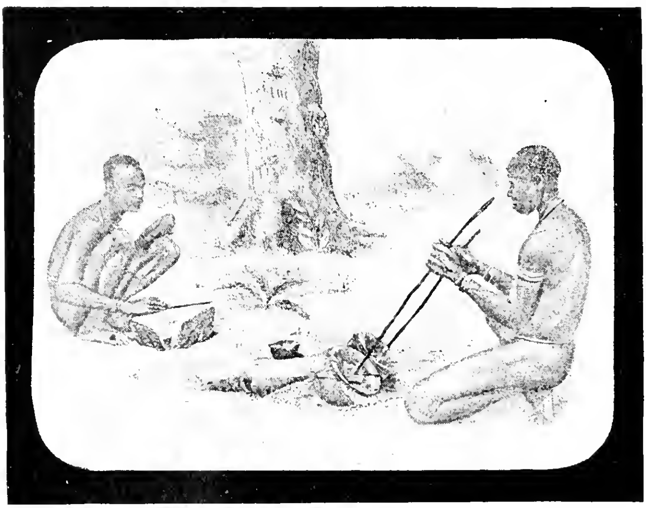

Fig. 11.—African Smiths at Work.

with charcoal. The upper receiver is filled with fragments of ore about a cubic inch in size. The hollow tunnel extends lower than the ground-level, and the melted ore, finding its way down through the fire, collects below. Openings here admit air and allow the withdrawal of slag. The iron has to be twice heated, and when taken out is in small bits which on reheating are beaten into one mass.

Metal-working had doubtless an exceedingly slow development; but it is remarkable how some people, strangers to the art as originators, acquire it as imitators. Thus the Sacs and Foxes

smelt no ores, but a dozen men in the tribe make from German silver neat and tasteful bracelets, armlets, rings, *sakahon*, and ear-rings. The jeweler's outfit consists of a square block of wood for an anvil, a hammer, a pair of shears, compasses, and a set of rude punches made from scrap iron, steel nails, bits of old files, etc. To make a finger-ring, the workman selects a piece of German silver and cuts from it a narrow strip long enough to encircle the finger. A square, rectangular, or oval piece of copper may be cut for a setting. This is marked with a neat design worked on with punches tapped by a hammer. The strip of white metal is bent into ring-form, the setting is laid upon it at the junction where the ends meet, and the two are firmly held together by a brass wire passed around them. A drop of solder is put upon the junction inside, a small stick is thrust through the ring to support it, and it is held in an open fire until the solder melts, flowing into the junction and cementing the whole firmly. After cooling, the ring is smoothed with a file and polished.

Sometimes we find the same object serving at once ornamental and useful purposes. The arm-rings of metal or ivory with which the African delights to cover his arms to the elbow are a useful protection against weapons. The metal rings worn by Latuka warriors on their right wrists are set with four or five sharp-edged knife-blades and are terrible weapons. The Isenga wear rings of considerable weight and sharp-edged; usually these are incased in leather sheaths, but, when uncovered, they become horrid weapons for hand-to-hand fighting. The very heavy arm-bands of the Wakamba are of triple use, serving at once as ornaments, parries, and striking weapons. Ornament often becomes money. The Nubian woman or the Hindoo frequently carries the family wealth on her person as silver ornaments. The important influence of ornament upon dress has already been considered in a preceding lecture.

We know of only one paper which treats at all fully of ornament. It is by Mougeolles. Although we do not concur in all the conclusions of this author, we wish to call attention to some propositions that he lays down. With the statement of these and of one or two additional, we shall close:

(*a*) *With the growth of dress, ornament declined.* If our view as to how dress developed is correct, this is natural. If dress began as ornament, the ornamental idea would gradually disappear as it passed into a modesty-covering and a bodily protection. As dress develops, the *sort* of ornament must change: ornament at first attached to the person, gradually passes into ornament attached to the dress. We notice here again an example of woman's conservatism. Man in civilization wears little ornament, and what he does wear is fastened to the dress; woman wears more

ornaments, and these are frequently attached to the person. Man in civilization still wears ornament "when he is a warrior, an officer, or a courtier." In all these cases we simply have *survival* of ornament in these conservative relations.

(*b*) *The search for ornament is as universal as the social inequality from which it has been derived.* We have seen that in its very beginnings ornament was a distinction. It was intended to mark a man from his fellows as one who had done what others had not accomplished. As the mark of social inequality it will exist wherever class distinctions are recognized.

(*c*) *Jewelry in ornament tends to grow more and more delicate with advancing civilization, and finally disappears as social distinctions vanish.* The first part of the proposition is shown by history. Ornament may be traced in Egypt, Greece, and Rome, and wherever there is actual progress toward true civilization ornament dwindles. The proposition as a whole grows out of the preceding. There is no place for ornaments in a true democracy where equality prevails. A revival of ornament indicates the retardation of democratic ideas.

(*d*) In our first lecture we referred to mutilations made to admit of ornament-carrying. We saw that ears, noses, cheeks, lips, and other parts are or have been pierced for insertion of ornaments. These *mutilations tend to disappear with advancement, and those which are most painful disappear first.* The least painful of these is ear-piercing, and we know that it still lingers in many cases where all other mutilations have disappeared.

(*e*) *In ornament as in dress we find much in the way of survival that is interesting.* Mougeolles claims that in the various head ornaments used as emblems of rank or power we have bits of history. He maintains that in very ancient Egypt masks were worn by hunters and warriors of the heads of slain animals. These are represented upon gods and goddesses in the *bas-reliefs.* The most commonly represented are made from heads of lions, jackals, etc. Isis wears a beef's head. Dog-headed figures are common. These animal head-dresses copied in other material continue in use, and, gradually conventionalized, lose their original form. He believes the crown was derived from a lion's head, the miter from that of a jackal, the Greek helmet from a horse's head.

(*f*) *Notice the importance, in its results, of personal vanity.* Without it we believe that man would have remained low in civilization. To the desire to mark himself off from his fellows by a visible sign we owe dress development; to it we owe a long list of important arts, chief among them perhaps that of metal-working; to it we owe much of the scientific method of studying the world around us: for, impelled by it, man first began to investigate Nature, beyond what was necessary to secure a food-supply

and bodily protection; to it we owe the development of our æsthetic sense in large degree. It may be true that to-day in a civilized democracy there is no proper place for personal ornament and decoration; but we can forgive much of weak display and many a useless survival of the past on account of what personal vanity has done for man's progress.

SOME OF THE POSSIBILITIES OF ECONOMIC BOTANY.*

By GEORGE LINCOLN GOODALE.

OUR Association demands of its president, on his retirement from office, some account of matters connected with the department of science in which he is engaged.

But you will naturally expect that, before I enter upon the discharge of this duty, I should present a report respecting the mission with which you intrusted me last year. You desired me to attend the annual meeting of the Australasian Association for the Advancement of Science, and express your good wishes for its success. Compliance with your request did not necessitate any material change in plans formed long ago to visit the South Seas; some of the dates and the sequence of places had to be modified; otherwise the early plans were fully carried out.

I can assure you that it seemed very strange to reverse the seasons, and find midsummer in January. But in the meeting with our brethren of the southern hemisphere nothing else was reversed. The official welcome to your representative was as cordial and the response by the members was as kindly as that which the people in the northern hemisphere would give to any fellow-worker coming from beyond the sea.

The meeting to which I was commissioned was held in January last in the cathedral city of Christchurch, New Zealand, the seat of Canterbury College.

Considering the distance between the other colonies and New Zealand, the meeting was well attended. From Hobart, Tasmania, to the southern harbor, known as the Bluff, in New Zealand, the sea voyage is only a little short of one thousand miles of rough water. From Sydney in New South Wales to Auckland, New Zealand, it is over twelve hundred miles. If, therefore, one journeys from Adelaide in South Australia, to Christchurch, New Zealand, where the meeting was held, he travels by land and by

* Presidential address delivered before the American Association for the Advancement of Science, at Washington, August, 1891.

sea over two thousand miles. From Brisbane in Queensland, it is somewhat farther. Although certain concessions are made to the members of the Association, the fares by rail and by steamship are high, so that a journey from any one of the seats of learning in Australia proper to New Zealand is formidable on account of its cost. It is remarkable that so large a number of members should have met together under such circumstances, and it speaks well for the great strength and vigor of the Association.

The Australasian Association is modeled rather more closely after the British Association than is our own. The president delivers his address upon his inauguration. There are no general business meetings, but all the details are attended to by an executive committee answering to our council; none except the members and associates are invited to attend even the sectional meetings, and there are some other differences between the three associations. The secretaries stated to me their conviction that their organization and methods are better adapted to their surroundings than ours would be, and all their arguments seemed cogent. Although the Association has been in existence but three years, it has accomplished great good. It has brought together workers in different fields for conference and mutual benefit; it has diminished misunderstandings, and has strengthened friendships. In short, it is doing the same kind of good work that we believe ours is now doing, and in much the same way.

Your message was delivered at the general evening session immediately before the induction of the new officers. The retiring president, Baron von Mueller, and the incoming president, Sir James Hector, in welcoming your representative, expressed their pleasure that you should have seen fit to send personal greetings.

In replying to their welcome, I endeavored to convey your felicitations upon the pronounced success of the Association, and your best wishes for a prosperous future. In your name I extended a cordial invitation to the members to gratify us by their presence at some of our annual meetings, and I have good reason to believe that this invitation will be accepted. I know it will be most thoroughly and hospitably honored by us.

On the morning of the session to which I refer, we received in the daily papers a cable telegram relative to the Bering Sea difficulties (which were then in an acute stage). In your stead, I ventured to say, "In these days of disquieting dispatches, when there are rumors of trouble between Great Britain and the United States, it is pleasant to think that 'blood is thicker than water.'" This utterance was taken to mean that we are all English-speaking kinsmen, and, even before I had finished, the old proverb was received with prolonged applause.

The next meeting of the Australasian Association is to be held in Hobart, the capital of Tasmania, under the presidency of the Governor, Sir Robert Hamilton. The energetic secretaries, Prof. Liversidge, Prof. Hutton, and Mr. Morton, promise a cordial welcome to any of our members visiting the Association. Should you accept the invitation, you will enjoy every feature of the remarkable island, Tasmania, where the meeting is to be held. You will be delighted by Tasmanian scenery, vegetation, and climate; but that which will give you the greatest enjoyment in this as in other English South Sea colonies is the fact that you are among English-speaking friends half-way around the world. You will find that their efficient Association is devoted to the advancement of science and the promotion of sound learning. In short, you will be made to feel at home.

The subject which I have selected for the valedictory address deals with certain industrial, commercial, and economic questions: nevertheless, it lies wholly within the domain of botany. I invite you to examine with me some of the possibilities of economic botany.

Of course, when treating a topic which is so largely speculative as this, it is difficult and unwise to draw a hard and fast line between possibilities and probabilities. Nowadays possibilities are so often realized rapidly that they become accomplished facts before we are aware.

In asking what are the possibilities that other plants than those we now use may be utilized we enter upon a many-sided inquiry.* Speculation is rife as to the coming man. May we not ask what plants the coming man will use?

There is an enormous disproportion between the total number of species of plants known to botanical science and the number of those which are employed by man.

The species of flowering plants already described and named are about one hundred and seven thousand. Acquisitions from unexplored or imperfectly explored regions may increase the aggregate perhaps one tenth, so that we are within very safe limits

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* The following are among the more useful works of a general character dealing with the subject. Others are referred to either in the text or notes. The reader may consult also the list of works on Economic Botany in the catalogue published by the Linnæan Society.

Select Extra-tropical Plants, readily Eligible for Industrial Culture or Naturalization, with Indications of their Native Countries and some of their Uses. By Baron Ferd. von Mueller, K. C. M. G., F. R. S., etc., Government Botanist for Victoria. Melbourne, 1888. Seventh edition, revised and enlarged.

At the close of his treatise on industrial plants, Baron von Mueller has grouped the genera indicating the different classes of useful products in such a manner that we can ascertain the respective numbers belonging to the genera. Of course, many of these

in taking the number of existing species to be somewhat above one hundred and ten thousand.*

Now, if we should make a comprehensive list of all the flowering plants which are cultivated on what we may call a fairly large scale at the present day, placing therein all food † and forage plants, all those which are grown for timber and cabinet woods, for fibers and cordage, for tanning materials, dyes, resins, rubber, gums, oils, perfumes, and medicines, we could bring together barely three hundred species. If we should add to this short catalogue all the species which, without cultivation, can be used by man, we should find it considerably lengthened. A great many products of the classes just referred to are derived in commerce from wild plants, but exactly how much their addition would extend the list it is impossible in the present state of knowledge to determine. Every enumeration of this character is likely to contain errors from two sources: first, it would be sure to contain some species which have outlived their real usefulness, and, secondly, owing to the chaotic condition of the literature of the subject, omissions would occur.

But after all proper exclusions and additions have been made

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genera figure in more than one category. He has also arranged the plants according to the countries *naturally producing them.*

Useful Native Plants of Australia (including Tasmania). By J. H. Maiden, F. L. S., Curator of the Technological Museum of New South Wales, Sydney. Sydney, 1889.

See also note (*), page 71.

Hand-book of Commercial Geography. By Geo. G. Chisholm, M. A., B. Sc. London, 1889.

New Commercial Plants, with Directions how to grow them to the Best Advantage. By Thomas Christy. London, Christy & Co.

Dictionary of Popular Names of the Plants which furnish the Natural and Acquired Wants of Man. By John Smith, A. L. S. London, 1885.

Cultivated Plants: Their Propagation and Improvement. By F. W. Burbage. London, 1877.

The Wanderings of Plants and Animals from their First home. By Victor Hehn, edited by James Steven Stallybrass. London, 1885.

Researches into the Early History of Mankind, and the Development of Civilization. By Edward B. Tylor, D. C. L., LL.D., F.R. S. 1878.

* The number of species of *Phænogamia* has been given by many writers as not far from 150,000. But the total number of species recognized by Bentham and Hooker, in the Genera Plantarum (Durand's Index), is 100,220, in 210 natural orders and 8,417 genera.

† Dr. E. Lewis Sturtevant, to whose kindness I am indebted for great assistance in the matter of references, has placed at my disposal many of his notes on edible plants, etc. From his enumeration it appears that, if we count all the plants which have been cultivated for food at one time or another, the list contains 1,192 species; but if we count all the plants which either "habitally or during famine periods are recorded to have been eaten," we obtain a list of no less than 4,690 species, or about three and one half per cent of all known species of plants. But, as Sir Joseph Hooker has said, the products of many plants, though eatable, are not fit to eat.

the total number of species of flowering plants utilized to any considerable extent by man in his civilized state does not exceed, in fact it does not quite reach, one per cent.

The disproportion between the plants which are known and those which are used becomes much greater when we take into account the species of flowerless plants also. Of the five hundred ferns and their allies we employ for other than decorative purposes only five; the mosses and liverworts, roughly estimated at five hundred species, have only four which are directly used by man. There are comparatively few algæ, fungi, or lichens which have extended use.

Therefore, when we take the flowering and flowerless together, the percentage of utilized plants falls far below the estimate made for the flowering alone.

Such a ratio between the number of species known and the number used justifies the inquiry which I have proposed for discussion at this name—namely, Can the short list of useful plants be increased to advantage? If so, how?

This is a practical question; it is likewise a very old one. In one form or another, by one people or another, it has been asked from early times. In the dawn of civilization, mankind inherited from savage ancestors certain plants, which had been found amenable to simple cultivation, and the products of these plants supplemented the spoils of the chase and of the sea. The question which we ask now was asked then. Wild plants were examined for new uses; primitive agriculture and horticulture extended their bounds in answer to this inquiry. Age after age has added slowly and cautiously to the list of cultivable and utilizable plants, but the aggregate additions have been, as we have seen, comparatively slight.

The question has thus no charm of novelty, but it is as practical to-day as in early ages. In fact, at the present time, in view of all the appliances at the command of modern science, and under the strong light cast by recent biological and technological research, the inquiry which we propose assumes great importance. One phase of it is being attentively and systematically regarded in the great experiment stations, another phase is being studied in the laboratories of chemistry and pharmacy, while still another presents itself in the museums of economic botany.

Our question may be put in other words, which are even more practical. What present likelihood is there that our tables may, one of these days, have other vegetables, fruits, and cereals than those which we use now? What chance is there that new fibers may supplement or even replace those which we spin and weave, that woven fabrics may take on new vegetable colors, that

flowers and leaves may yield new perfumes and flavors? What probability is there that new remedial agents may be found among plants neglected or now wholly unknown? The answer which I shall attempt is not in the nature of a prophecy; it can claim no higher rank than that of a reasonable conjecture.

At the outset it must be said that synthetic chemistry has made and is making some exceedingly short cuts across this field of research, giving us artificial dyes, odors, flavors, and medicinal substances of such excellence that it sometimes seems as if before long the old-fashioned chemical processes in the plant itself would play only a subordinate part. But although there is no telling where the triumphs of chemical synthesis will end, it is not probable that it will ever interfere essentially with certain classes of economic plants. It is impossible to conceive of a synthetic fiber or a synthetic fruit. Chemistry gives us fruit-ethers and fruit-acids, and after a while may provide us with a true artificial sugar and amorphous starch; but artificial fruits worth the eating or artificial fibers worth the spinning are not coming in our day.

Despite the extraordinary achievements of synthetic chemistry, the world must be content to accept, for a long time to come, the results of the intelligent labor of the cultivator of the soil and the explorer of the forest. Improvement of the good plants we now utilize, and the discovery of new ones, must remain the care of large numbers of diligent students and assiduous workmen. So that, in fact, our question resolves itself into this: Can these practical investigators hope to make any substantial advance?

It will be well to glance first at the manner in which our wild and cultivated plants have been singled out for use. We shall, in the case of each class, allude to the methods by which the selected plants have been improved, or their products fully utilized. Thus, looking the ground over, although not minutely, we can see what new plants are likely to be added to our list. Our illustrations can, at the best, be only fragmentary.

We shall not have time to treat the different divisions of the subject in precisely the proportions which would be demanded by an exhaustive essay; an address on an occasion like this must pass lightly over some matters which other opportunities for discussion could properly examine with great fullness. Unfortunately, some of the minor topics which must be thus passed by possess considerable popular interest; one of these is the first subordinate question introductory to our task, namely, How were our useful cultivated and wild plants selected for use?

A study of the early history of plants employed for ceremonial purposes, in religious solemnities, in incantations, and for medici-

nal uses shows how slender has sometimes been the claim of certain plants to the possession of any real utility. But some of the plants which have been brought to notice in these ways have afterward been found to be utilizable in some fashion or other. This is often seen in the cases of the plants which have been suggested for medicinal use through the absurd doctrine of signatures.*

It seems clear that, except in modern times, useful plants have been selected almost wholly by chance, and it may well be said that a selection by accident is no selection at all. Nowadays the new selections are based on analogy. One of the most striking illustrations of the modern method is afforded by the utilization of bamboo fiber for electric lamps.

Some of the classes of useful plants must be passed by without present discussion; others alluded to slightly; while still other groups fairly representative of selection and improvement will be more fully described. In this latter class would naturally come, of course, the food-plants known as

I. THE CEREALS.—Let us look first at these.

The species of grasses which yield these seed-like fruits, or, as we might call them for our purpose, seeds, are numerous;† twenty of them are cultivated largely in the Old World, but only six of them are likely to be very familiar to you, namely, wheat, rice, barley, oats, rye, and maize. The last of these is of American origin, despite doubts which have been cast upon it. It was not known in the Old World until after the discovery of the New. It has probably been very long in cultivation. The others all belong to the Old World. Wheat and barley have been cultivated from the earliest times; according to De Candolle, the chief authority in these matters, about four thousand years. Later came rye and oats, both of which have been known in cultivation for at least two thousand years. Even the shorter of these periods gives time enough for wide variation, and, as is to be expected, there are numerous varieties of them all. For instance, Vilmorin, in 1880, figured sixty-six varieties of wheat with plainly distinguishable characters.‡

If the Chinese records are to be trusted, rice has been cultivated for a period much longer than that assigned by our history and traditions to the other cereals, and the varieties are correspondingly numerous. It is said that in Japan above three hun-

* The Folk Lore of Plants. By T. F. Thiselton Dyer, 1889.

† In Dr. Sturtevant's list, 88 species of *Gramineæ* are counted as food-plants under cultivation, while the number of species in this order which can be or have been utilized as food amounts to 146. Our smaller number 20 comprises only those which have been grown on a large scale anywhere.

‡ "In Agricultural Museum at Poppelsdorf 600 varieties are exhibited."

dred varieties are grown on irrigated lands, and more than one hundred on uplands.*

With the possible exception of rice, not one of the species of cereals is certainly known in the wild state.† Now and then specimens have been gathered in the East which can be referred to the probable types from which our varieties have sprung, but doubt has been thrown upon every one of these cases. It has been shown conclusively that it is easy for a plant to escape from cultivation and persist in its new home even for a long time in a near approximation to cultivated form. Hence, we are forced to receive all statements regarding the wild forms with caution. But it may be safely said that if all the varieties of cereals which we now cultivate were to be swept out of existence, we could hardly know where to turn for wild species with which to begin again. We could not know with certainty.

To bring this fact a little more vividly to our minds, let us suppose a case. Let us imagine that a blight without parallel has brought to extinction all the forms of wheat, rice, rye, oats, barley, and maize now in cultivation, but without affecting the other grasses or any other form of vegetable food. Mankind would be obliged to subsist upon the other kindly fruits of the earth—upon root-crops, tubers, leguminous seeds, and so on. Some of the substitutions might be amusing in any other time than that of a threatened famine. Others would be far from appetizing under any condition, and only a few would be wholly satisfying even to the most pronounced vegetarian. In short, it would seem, from the first, that the cereals fill a place occupied by no other plants. The composition of the grains is theoretically and practically almost perfect as regards food ratio between the nitrogenous matters and the starch group; and the food value, as it is termed, is high. But, aside from these considerations, it would be seen that for safety of preservation through considerable periods, and for convenience of transportation, the cereals take highest rank. Pressure would come from every side to compel us to find equivalents for the lost grains. From this predicament I believe that the well-equipped experiment stations and the Agricultural Departments in Europe and America would by and by extricate us. Continuing this hypothetical case, let us next inquire how the stations would probably go to work in the up-hill task of making partially good a well-nigh irreparable loss.

The whole group of relatives of the lost cereals would be passed

* E. L. S. in letter, quoted from Seedsman's Catalogue.

† The best account of the early history of these and other cultivated plants can be found in the classical work of De Candolle, Origine des Plantes Cultivées (Paris), translated in the International Series, History of Cultivated Plants (New York). The reader should consult also Darwin's Animals and Plants under Domestication.

in strict review. Size of grain, strength and vigor and plasticity of stock, adaptability to different surroundings, and flexibility in variation would be examined with scrupulous care.

But the range of experiment would, under the circumstances, extend far beyond the relatives of our present cereals. It would embrace an examination of the other grasses which are even now cultivated for their grains, but which are so little known, outside of their own limit, that it is a surprise to hear about them. For example, the millets, great and small, would be investigated. These grains, so little known here, form an important crop in certain parts of the East. One of the leading authorities on the subject * states that the millets constitute "a more important crop" in India "than either rice or wheat, and are grown more extensively, being raised from Madras in the south to Rajputana in the north. They occupy about eighty-three per cent of the food-grain area in Bombay and Sinde, forty-one per cent in the Punjab, thirty-nine per cent in the central provinces," "in all about thirty million acres."

Having chosen proper subjects for experimenting, the cultivators would make use of certain well-known principles. By simple selection of the more desirable seeds, strains would be secured to suit definite wants, and these strains would be kept as races, or attempts would be made to intensify wished-for characters. By skillful hybridizing of the first, second, and higher orders, tendencies to wider variation would be obtained and the process of selection considerably expedited.†

It is out of our power to predict how much time would elapse before satisfactory substitutes for our cereals could be found. In the improvement of the grains of grasses other than those which have been very long under cultivation, experiments have been few, scattered, and indecisive. Therefore we are as badly off for time-ratios as are the geologists and archæologists in their statements of elapsed periods. It is impossible for us to ignore the fact that there appear to be occasions in the life of a species when it seems to be peculiarly susceptible to the influence of its sur-

* Food-grains of India, A. H. Church, London, 1886, p. 34. In this instructive work the reader will find much information regarding the less common articles of food. Of *Panicum frumentaceum*, Prof. Georgeson states in a letter that it is grown in Japan for its grain, which is used for food, but here would take rank as a fodder-plant.

† In order to avoid possible misapprehension, it should be stated that there are a few persons who hold that at least some of our cereals, and other cultivated plants, for that matter, have not undergone material improvement, but are essentially unmodified progeny. Under this view, if we could look back into the farthest past, we should see our cereals growing wild and in such admirable condition that we should unhesitatingly select them for immediate use. This extreme position is untenable. Again, there are a few extremists who hold that some plants under cultivation have reached their culminating point, and must now remain stationary or begin to retrograde.

roundings.* A species, like a carefully laden ship, represents a balancing of forces within and without. Disturbance may come through variation from within, as from a shifting of the cargo, or in some cases from without. We may suppose both forces to be active in producing variation, a change in the internal condition rendering the plant more susceptible to any change in its surroundings. Under the influence of any marked disturbance, a state of unstable equilibrium may be brought about, at which times the species as such is easily acted upon by very slight agencies.

One of the most marked of these derangements is a consequent of cross-breeding within the extreme limits of varieties. The resultant forms in such cases can persist only by close breeding or by propagation from buds or the equivalents of buds. Disturbances like these arise unexpectedly in the ordinary course of nature, giving us sports of various kinds. These critical periods, however, are not unwelcome, since skillful cultivators can take advantage of them. In this very field much has been accomplished. An attentive study of the sagacious work done by Thomas Andrew Knight shows to what extent this can be done.† But we must confess that it would be absolutely impossible to predict with certainty how long or how short would be the time before new cereals or acceptable equivalents for them would be provided. Upheld by the confidence which I have in the intelligence, ingenuity, and energy of our experiment stations, I may say that the time would not probably exceed that of two generations of our race, or half a century.

In now laying aside our hypothetical illustration, I venture to ask why it is that our experiment stations, and other institutions dealing with plants and their improvement, do not undertake investigations like those which I have sketched? Why are not some of the grasses other than our present cereals studied with reference to their adoption as food-grains? One of these species will naturally suggest itself to you all, namely, the wild rice of the lakes.‡ Observations have shown that, were it not for the

* Gray's Botanical Text-Book, vols. i and ii.

† A Selection from the Physiological and Horticultural Papers published in the Transactions of the Royal and Horticultural Societies, by the late Thomas Andrew Knight, Esq., President of the Horticultural Society, London. London, 1841.

‡ Illustrations of the Manners and Customs and Condition of the North American Indians. By George Catlin. London, 1876. A reprint of the account published in 1841, of travels in 1832–'40. "Plate 278 is a party of Sioux, in bark canoes (purchased of the Chippewas), gathering the wild rice, which grows in immense fields around the shores of the rivers and lakes of these northern regions, and used by the Indians as an article of food. The mode of gathering it is curious and, as seen in the drawing, one woman paddles the canoe, while another with a stick in each hand bends the rice over the canoe with one and strikes it with the other, which shakes it into the canoe, which is constantly moving along until it is filled." Vol. ii, p. 208.

difficulty of harvesting these grains, which fall too easily when they are ripe, they might be utilized. But attentive search might find or educe some variety of *Zizania* with a more persistent grain and a better yield. There are two of our sea-shore grasses which have excellent grains, but are of small yield. Why are not these, or better ones which might be suggested by observation, taken in hand?

The reason is plain. We are all content to move along in lines of least resistance, and are disinclined to make a fresh start. It is merely leaving well enough alone, and, so far as the cereals are concerned, it is indeed well enough. The generous grains of modern varieties of wheat and barley compared with the well-preserved charred vestiges found in Greece by Schliemann,* and in the lake-dwellings,† are satisfactory in every respect. Improvements, however, are making in many directions; and in the cereals we now have we possess far better and more satisfactory material for further improvement, both in quality and as regards range of distribution, than we could reasonably hope to have from other grasses.

From the cereals we may turn to the interesting groups of plants comprised under the general term

II. VEGETABLES.—Under this term it will be convenient for us to include all plants which are employed for culinary purposes, or for table use, such as salads and relishes.

The potato and sweet potato, the pumpkin and squash, the red or capsicum peppers, and the tomato, are of American origin.

All the others are, most probably, natives of the Old World. Only one plant coming in this class has been derived from southern Australasia, namely, New Zealand spinach (*Tetragonia*).

Among the vegetables and salad-plants longest in cultivation

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* Schliemann's carbonized specimens exhumed in Greece are said to be "very hard, fine-grained, sharp, very flat on grooved side, different from any wheats now known." American Antiquities, 1880, p. 66. The carbonized grains in the Peabody Museum at Cambridge, Mass., are small.

† Prehistoric Times as illustrated by Ancient Remains and the Manners and Customs of Modern Savages. By John Lubbock, Bart. New York, fourth edition, 1886. "Three varieties of wheat were cultivated by the lake-dwellers, who also possessed two kinds of barley and two of millet. Of these the most ancient and most important were the six-rowed barley and small "lake-dwellers'" wheat. The discovery of Egyptian wheat (*Triticum turgidum*), at Wangen and Robenhausen, is particularly interesting. Oats were cultivated during the bronze age, but are absent from all the stone age villages. Rye was also unknown" (p. 216). "Wheat is most common, having been discovered at Merlen, Moosseedorf, and Wangen. At the latter place, indeed, many bushels of it were found, the grains being in large, thick lumps. In other cases the grains are free, and without chaff, resembling our present wheat in size and form, while more rarely they are still in the ear." One hundred and fifteen species of plants have been identified (Heer, Keller).

we may enumerate the following: turnip, onion, cabbage, purslane, the large bean (*Faba*), chick-pea, lentil, and one species of pea, garden pea. To these an antiquity of at least four thousand years is ascribed.

Next to these, in point of age, come the radish, carrot, beet, garlic, garden cress and celery, lettuce, asparagus, and the leek. Three or four leguminous seeds are to be placed in the same category, as are also the black peppers.

Of more recent introduction the most prominent are the parsnip, oyster-plant, parsley, artichoke, endive, and spinach.

From these lists I have purposely omitted a few which belong exclusively to the tropics, such as certain yams.

The number of varieties of these vegetables is astounding. It is, of course, impossible to discriminate between closely allied varieties which have been introduced by gardeners and seedsmen under different names, but which are essentially identical, and we must therefore have recourse to a conservative authority, Vilmorin,* from whose work a few examples have been selected. The varieties which he accepts are sufficiently well distinguished to admit of description, and in most instances of delineation, without any danger of confusion. The potato has, he says, innumerable varieties, of which he accepts forty as easily distinguishable and worthy of a place in a general list, but he adds also a list, comprising, of course, synonyms, of thirty-two French, twenty-six English, nineteen American, and eighteen German varieties. The following numbers speak for themselves, all being selected in the same careful manner as those of the potato: celery, more than twenty; carrot, more than thirty; beet, radish, and potato, more than forty; lettuce and onion, more than fifty; turnip, more than seventy; cabbage, kidney-bean, and garden pea, more than one hundred.

The amount of horticultural work which these numbers represent is enormous. Each variety established as a race (that is, a variety which comes true to seed) has been evolved by the same sort of patient care and waiting which we have seen is necessary in the case of cereals, but the time of waiting has not been as a general thing so long.

You will permit me to quote from Vilmorin † also an account of a common plant, which will show how wide is the range of variation and how obscure are the indications in the wild plant of its available possibilities. The example shows how completely hidden are the potential variations useful to mankind:

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* *Les Plantes Potagères*, Vilmorin, Paris. Translated into English under the direction of W. Robinson, Editor of the (London) Garden, 1885, and entitled The Vegetable Garden.

† *Loc. cit.*, English edition, p. 104.

Cabbage, a plant which is indigenous in Europe and western Asia, is one of the vegetables which has been cultivated from the earliest time. The ancients were well acquainted with it, and certainly possessed several varieties of the head-forming kinds. The great antiquity of its culture may be inferred from the immense number of varieties which are now in existence, and from the very important modifications which have been produced in the characteristics in the origiual or parent plant.

The wild cabbage, such as it now exists on the coasts of England and France, is a perennial plant with broad-lobed, undulated, thick, smooth leaves, covered with a glaucous bloom. The stem attains a height of from nearly two and a half to over three feet, and bears at the top a spike of yellow or sometimes white flowers. All the cultivated varieties present the same peculiarities in their inflorescence, but up to the time of flowering they exhibit most marked differences from each other and from the original wild plant. In most of the cabbages it is chiefly the leaves that are developed by cultivation; these for the most part become imbricated or overlap one another closely, so as to form a more or less compact head, the heart or interior of which is composed of the central undeveloped shoot and the younger leaves next it. The shape of the head is spherical, sometimes flattened, sometimes conical. All the varieties which form heads in this way are known by the general name of cabbages, while other kinds with large branching leaves which never form heads are distinguished by the name of borecole or kale.

In some kinds the flower stems have been so modified by culture as to become transformed into a thick, fleshy, tender mass, the growth and enlargement of which are produced at the expense of the flowers, which are absorbed and rendered abortive. Such are the broccolis and cauliflowers.

But this plant has other transformations.

In other kinds the leaves retain their ordinary dimensions, while the stem or principal root has been brought by cultivation to assume the shape of a large ball or turnip, as in the case of the plants known as kohl-rabi and turnip-rooted cabbage or Swedish turnip. And, lastly, there are varieties in which cultivation and selection have produced modifications in the ribs of the leaves, as in their couve tronchuda, or in the axillary shoots (as in Brussels sprouts), or in several organs together, as in the marrow kales and the Neapolitan curled kale.

Here are important morphological changes like those to which Prof. Bailey has called attention in the case of the tomato.

Suppose we are strolling along the beach at some of the seaside resorts of France, and should fall in with this coarse cruciferous plant, with its sprawling leaves and strong odor. Would there be anything in its appearance to lead us to search for its hidden merit as a food-plant? What could we see in it which would give it a preference over a score of other plants at our feet? Again, suppose we are journeying in the highlands of Peru, and should meet with a strong-smelling plant of the nightshade family, bearing a small irregular fruit, of subacid taste and of peculiar flavor. We will further imagine that the peculiar taste strikes our fancy, and we conceive that the plant has possibilities as a source of food. We should be led by our knowledge of the potato, probably a native of the same region, to think that this allied plant

might be safely transferred to a northern climate; but would there be promise of enough future usefulness, in such a case as this, to warrant our carrying the plant north as an article of food? Suppose, further, we should ascertain that the fruit in question was relished not only by the natives of its home, but that it had found favor among the tribes of south Mexico and Central America, and had been cultivated by them until it had attained a large size; should we be strengthened in our venture? Let us go one step further still. Suppose that having decided upon the introduction of the plant, and having urged everybody to try it, we should find it discarded as a fruit, but taking a place in gardens as a curiosity under an absurd name, or as a basis for preserves and pickles; should we not look upon our experiment in the introduction of this new plant as a failure? This is not a hypothetical case.

The tomato,* the plant in question, was cultivated in Europe as long ago as 1554; † it was known in Virginia in 1781 and in the Northern States in 1785; but it found its way into favor slowly, even in this land of its origin. A credible witness states that in Salem it was almost impossible to induce people to eat or even taste of the fruit. And yet, as you are well aware, its present cultivation on an enormous scale in Europe and this country is scarcely sufficient to meet the increasing demand.

A plant which belongs to the family of the tomato has been known to the public under the name of the strawberry tomato. The juicy yellow or orange-colored fruit is inclosed in a papery calyx of large size. The descriptions which were published when the plant was placed on the market were attractive, and were not exaggerated to a misleading extent. But, as you all know, the plant never gained any popularity. If we look at these two cases carefully we shall see that what appears to be caprice on the part of the public is at bottom common sense. The cases illustrate as well as any which are at command the difficulties which surround the whole subject of the introduction of new foods.

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* According to notes made by Mr. Manning, Secretary Massachusetts Horticultural Society (History Massachusetts Horticultural Society), the tomato was introduced into Salem, Mass., about 1802 by Michele Felice Corne, an Italian painter, but he found it difficult to persuade people even to taste the fruit (Felt's Annals of Salem, vol. ii, p. 631). It was said to have been introduced into Philadelphia by a French refugee from Santo Domingo in 1798. It was used as an article of food in New Orleans in 1812, but was not sold in the markets of Philadelphia until 1829. It did not come into general use in the North until some years after the last-named date.

† "In Spain and those hot regions, they use to eat the (love) apples prepared and boiled with pepper, salt, and olives; but they yield very little nourishment to the bodies, and the same nought and corrupt. Likewise they doe eat the apples with oile, vinegar, and pepper mixed together for sauce to their meat even as we in these Cold Countries do Mustard." (Gerard's Herbal, p. 346.)

Before asking specifically in what direction we shall look for new vegetables I must be pardoned for calling attention, in passing, to a very few of the many which are already in limited use in Europe and this country, but which merit a wider employment. Cardon, or cardoon; celeriac, or turnip-rooted celery; fetticus, or corn-salad; martynia; salsify; sea-kale; and numerous small salads, are examples of neglected treasures of the vegetable garden.

The following, which are even less known, may be mentioned as fairly promising:*

1. *Arracacia esculenta,* called arracacha, belonging to the parsley family. It is extensively cultivated in some of the northern states of South America. The stems are swollen near the base and produce tuberous enlargements filled with an excellent starch. Although the plant is of comparatively easy cultivation, efforts to introduce it into Europe have not been successful, but it is said to have found favor in both the Indies, and may prove useful in our Southern States.

2. *Ullucus* or ollucus, another tuberous-rooted plant from nearly the same region, but belonging to the beet or spinach family. It has produced tubers of good size in England, but they are too waxy in consistence to dispute the place of the better tubers of the potato. The plant is worth investigating for our hot, dry lands.

3. A tuber-bearing relative of our common hedge-nettle, or *Stachys,* is now cultivated on a large scale at Crosnes, in France, for the Paris market. Its name in Paris is taken from the locality where it is now grown for use. Although its native country is Japan, it is called by some seedsmen Chinese artichoke. At the present stage of cultivation the tubers are small and are rather hard to keep, but it is thought that, "both of these defects can be overcome or evaded."† Experiments indicate that we have in this species a valuable addition to our vegetables. We must next look at certain other neglected possibilities.

Dr. Edward Palmer,‡ whose energy as a collector and acute-

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* Commercial Botany of the Nineteenth Century. By John R. Jackson, A. L. S. Cassell & Co. London, 1890. Mr. Jackson, who is the Curator of the Museums, Royal Gardens, Kew, has embodied in this treatise a great amount of valuable information, well arranged for ready reference.

† Gardener's Chronicle, 1888.

‡ Department of Agriculture Report for 1870, pp. 404–428. Only those are here copied from Dr. Palmer's list which he expressly states are extensively used:

Ground-nut (*Apios tuberosa*); *Aesculus californica; Agave americana; Nuphar advena;* prairie potato (*Psoralea esculenta*); *Scirpus lacustris; Sagittaria variabilis;* kamass-root (*Camassia esculenta*); *Solanum Fendleri* (supposed by him to be the original of the cultivated potato); acorns of various sorts; mesquite (*Algarobia glandulosa; Juniperus occidentalis;* nuts of *Carya, Juglans,* etc.; screw-bean (*Strombocarpus pubescens*);

ness as an observer are known to you all, has brought together very interesting facts relative to the food-plants of our North American aborigines. Among the plants described by him there are a few which merit careful investigation. Against all of them, however, there lie the objections mentioned before, namely:

1. The long time required for their improvement, and—

2. The difficulty of making them acceptable to the community, involving—

3. The risk of total and mortifying failure.

In the notes to this address the more prominent of these are enumerated.

In 1854 the late Prof. Gray called attention to the remarkable relations which exist between the plants of Japan and those of our Eastern coast. You will remember that he not only proved that the plants of the two regions had a common origin, but also emphasized the fact that many species of the two countries are

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various cactaceæ; *Yucca;* cherries and many wild berries; *Chenopodium album*, etc. *Psoralea esculenta* = prairie potato, or bread-root. (Palmer in Agricultural Report, 1870, p. 402). The following from Catlin, *loc. cit.*, i, p. 122: "Corn and dried meat are generally laid in in the fall, in sufficient quantities to support them through the winter. These are the principal articles of food during that long and inclement season; and, in addition to them, they oftentimes have in store great quantities of dried squashes, and dried 'pommes blanches,' a kind of turnip which grows in great abundance in those regions. . . . These are dried in great quantities and pounded into a sort of meal and cooked with dried meat and corn. Great quantities also are dried and laid away in store for the winter season, such as buffalo-berries, service-berries, strawberries, and wild plums. In addition to this we had the luxury of service-berries without stint; and the buffalo bushes, which are peiarule to these northern regions, lined the banks of the river and the defiles in the bluffs, sometimes for miles together, forming almost impassable hedges, so loaded with the weight of their fruit that their boughs everywhere gracefully bending down or resting on the ground. This last shrub (*Shepherdia*), which may be said to be the most beautiful ornament that decks out the wild prairies, forms a striking contrast to the rest of the foliage, from the blue appearance of its leaves by which it can be distinguished for miles in distance. The fruit which it produces in such incredible profusion, hanging in clusters to every limb and to every twig, is about the size of ordinary currants and not unlike them in color and even in flavor; being exceedingly acid, almost unpalatable, until they are bitten by frost of autumn, when they are sweetened and their flavor delicious, having to the taste much the character of grapes, and I am almost fain to think would produce excellent wine." (George Catlin's Illustrations and Manners, Customs, and Condition of the North American Indians, p. 72, vol. i.) For much relative to the food of our aborigines, especially of the Western coast, consult The Native Races of the Pacific States of North America. By H. H. Bancroft. New York, 1875. The following from vol. i, p. 538, indicates that inaccuracies have crept into the work: "From the earliest information we have of these nations" (the author is speaking of the New Mexicans), "they are known to have been tillers of the soil; and though the implements used and their methods of cultivation were both simple and primitive, cotton, corn, *wheat*, beans, and many varieties of fruits which constituted their principal food were raised in abundance." Wheat was not grown on the American continent until after the landing of the first explorers.

almost identical. It is to that country, which has yielded us so many useful and beautiful plants, that we turn for new vegetables to supplement our present food resources. One of these plants, namely, *Stachys*, has already been mentioned as rather promising. There are others which are worth examination and perhaps acquisition.

One of the most convenient places for a preliminary examination of the vegetables of Japan is at the railroad stations on the longer lines—for instance, that running from Tokio to Kobe. For native consumption there are prepared luncheon-boxes of two or three stories, provided with the simple and yet embarrassing chopsticks. It is worth the shock it causes one's nerves to invest in these boxes and try the vegetable contents. The bits of fish, flesh, and fowl which one finds therein can be easily separated and discarded, upon which there will remain a few delicacies. The pervading odor of the box is that of aromatic vinegar. The generous portion of boiled rice is of excellent quality with every grain well softened and distinct, and this without anything else would suffice for a tolerable meal. In the boxes which have fallen under my observation there were sundry boiled roots, shoots, and seeds which were not recognizable by me in their cooked form. Prof. Georgeson,* formerly of Japan, has kindly identified some of these for me, but he says, "There are doubtless many others used occasionally."

One may find sliced lotus roots, roots of large burdock, lily bulbs, shoots of ginger, pickled green plums, beans of many sorts, boiled chestnuts, nuts of the gingko tree, pickled greens of various kinds, dried cucumbers, and several kinds of sea-weeds. Some of the leaves and roots are cooked in much the same manner as beet roots and beet leaves are by us, and the general effect is not unappetizing. The boiled shoots are suggestive of only the tougher ends of asparagus. On the whole, I do not look back on Japanese railway luncheons with any longing which would compel me to advocate the indiscriminate introduction of the constituent vegetables here.

But when the same vegetables are served in native inns, under more favorable culinary conditions, without the flavor of vinegar

* Pickled daikon, the large radish, often grated. Ginger-roots—shoga. Beans (*Glycine hispida*), many kinds, and prepared in many ways. Beans (*Dolichos cultratus*), cooked in rice and mixed with it. Sliced hasu, lotus roots. Lily bulbs, boiled whole and the scales torn off as they are eaten. Pickled green plums (ume-boshi), colored red in the pickle by the leaves of *Perilla arguta* (shiso). Sliced and dried cucumbers, kiuri. Pieces of gobo—roots of *Lappa major*. Rakkio—bulbs of *Allium Bakeri*, boiled in shogu. Grated wasabi—stem of *Eutrema wasabi*. Water-cress—midzu-tagarashi (not often). Also sometimes pickled greens of various kinds, and occasionally chestnut-kernels boiled and mixed with a kind of sweet sauce. Nut of the gingko tree. Several kinds of sea-weeds are also very commonly served with the rice. Prof. C. C. Georgeson in letter.

and of the pine wood of the luncheon-boxes, they appear to be worthy of a trial in our horticulture, and I therefore deal with one or two in greater detail.

Prof. Georgeson, whose advantages for acquiring a knowledge of the useful plants of Japan have been unusually good, has placed me under great obligations by communicating certain facts regarding some of the more promising plants of Japan which are not now used here. It should be said that several of these plants have already attracted the notice of the Agricultural Department in this country.

The soy bean (*Glycine hispida*). This species is known here to some extent, but we do not have the early and best varieties. These beans replace meat in the diet of the common people.

Mucuna (*Mucuna capitata*) and dolichos (*Dolichos cultratus*) are pole-beans possessing merit.

Dioscorea; there are several varieties with palatable roots. Years ago one of these was spoken of by the late Dr. Gray as possessing "excellent roots, if one could only dig them."

Colocasia antiquorum has tuberous roots, which are nutritious.

Conophallus Konjak has a large bulbous root, which is sliced, dried, and beaten to a powder. It is an ingredient in cakes.

Aralia cordata is cultivated for the shoots, and used as we use asparagus.

Œnanthe stolonifera and *Cryptotœnia canadensis* are palatable salad plants, the former being used also as greens.

There is little hope, if any, that we shall obtain from the hotter climates for our southern territory new species of merit. The native markets in the tropical cities, like Colombo, Batavia, Singapore, and Saigon, are rich in fruits, but, outside of the native plants bearing these, nearly all the plants appear to be wholly in established lines of cultivation, such, for instance, as members of the gourd and nightshade families.

Before we leave the subject of our coming vegetables, it will be well to note a *naïve* caution enjoined by Vilmorin in his work, Les Plantes Potagères.*

"Finally," he says, "we conclude the article devoted to each plant with a few remarks on the uses to which it may be applied and on the parts of the plants which are to be so used. In many cases such remarks may be looked upon as idle words, and yet it would sometimes have been useful to have them when new plants were cultivated by us for the first time. For instance, the giant edible burdock of Japan (*Lappa edulis*) was for a long time served up on our tables only as a wretchedly poor spinach, be-

* *Loc. cit.* Preface in English edition.

cause people would cook the leaves, whereas, in its native country, it is only cultivated for its tender, fleshy roots."

I trust you are not discouraged at this outlook for our coming vegetables.

Two groups of improvable food-plants may be referred to before we pass to the next class, namely, edible fungi and the beverage-plants. All botanists who have given attention to the matter agree with the late Dr. Curtis, of North Carolina, that we have in the unutilized mushrooms an immense amount of available nutriment of a delicious quality. It is not improbable that other fungi than our common "edible mushroom" will by and by be subjected to careful selection.

The principal beverage-plants—tea, coffee, and chocolate—are all attracting the assiduous attention of cultivators. The first of these plants is extending its range at a marvelous rate of rapidity through India and Ceylon; the second is threatened by the pests which have almost exterminated it in Ceylon, but a new species, with crosses therefrom, is promising to resist them successfully; the third, chocolate, is every year passing into lands farther from its original home. To these have been added the kola, of a value as yet not wholly determined, and others are to augment the short list.

[*To be concluded.*]

LESSONS FROM THE CENSUS.

BY CARROLL D. WRIGHT, A. M.,

UNITED STATES COMMISSIONER OF LABOR.

II.

TO my own mind, the Federal census system is faulty in many features. It is bungling, unwieldy, and unproductive of scientific results. It is the legitimate growth of time and the honest endeavor to secure broader and broader results to satisfy the growing demand for information concerning all the conditions of the people, and it is perfectly natural that the additions from time to time should have resulted in the present system. The system should be changed radically before another census period comes around.

To be specific in the condemnation of our system, attention should be paid, first, to the method of enumeration. Vicious as it is, it is a vast improvement upon that existing prior to 1880. There are four methods of enumeration, or rather four methods of enumeration have been tried on pretty extensive scales. The English method consists in securing all the facts called for under

the law in one day. For this purpose a vast army of enumerators is appointed from the central office.* The organization under the British Census Act is under the control of the Local Government Board, and the immediate chief is the Registrar-General. Local registrars of births and deaths must divide their subdistricts into enumerators' divisions, in accordance with instructions from the Registrar-General, and subject to his final supervision and approval. Every registrar of births and deaths must furnish to his superintendent registrar lists containing names, occupations, and places of abode of a sufficient number of persons qualified, according to instructions, to act as enumerators within a subdistrict, and such persons, if approved by the superintendent registrar, shall be appointed enumerators for taking the census. The board causes to be prepared a table of allowances to be made to the several enumerators, registrars, superintendent registrars, and other persons employed in taking the census; and such table, when approved by the Treasury, is laid before both Houses of Parliament for their action. Under the act the schedule comprehends eleven inquiries, relating to the members of the family, visitors, boarders, and servants who slept or abode in the dwelling on the night of Sunday, April 5, 1891, and the schedule was called for on Monday, April 6th, by the appointed enumerator, whose business it was to see that the schedule was properly filled by the head of the household, and, if not, to cause it to be so filled. This method seems to be the one that attracts the attention of statisticians as the ideal method. Under it, however, much complaint exists in Great Britain, not only as to the processes of carrying out the law, but relative to the inaccuracies in the returns; and I have been informed that much difficulty is experienced in obtaining well-filled schedules. It is unreasonable to suppose that in a population varying widely in the intelligence of its individual members a schedule can be properly filled or so well filled as to secure a reasonably scientific result. The English census has been extolled for its accuracy. I do not believe it is any more accurate than any other census taken by other methods. I have before me a discarded schedule—that is, an improperly filled one—left with an intelligent mechanic, well educated, of wide experience, a machinist by trade, and perfectly competent to write an article for a magazine; and yet he could not, or did not, properly fill the schedule left with him, and on an examination of it it is not strange that he did not. When the difficulties of filling the simple English schedule are considered, it becomes pre-

* In an article in the North American Review for June, 1889, I stated that the English census was taken through the constabulary. I made this statement on most excellent authority. It was, however, an error.

posterous to suppose that the expanded schedule under the Federal system could be filled under the English method. This has been tried, and in a State where the population has been taught to consider the value of statistics—the Commonwealth of Massachusetts. In 1875 the English method was adopted; the schedules, comprehending all the inquiries at that time called for by law, were left with the heads of families, with clearly defined instructions, sample sheets, etc., all in accordance with the recognized English method; and from that community, which, it is reasonable to suppose, could fill the census schedules if any community could do it, but thirty-seven per cent of the returns were in a condition for use. The balance had to be corrected or made entirely by the enumerators. That method was therefore abandoned in subsequent censuses for the State of Massachusetts. With the sparsely settled population of the United States, and with the broad schedule of the Federal census, covering as it does twenty-four inquiries, it would be absurd to attempt to take the census under the English system.

In Germany the labor of enumeration is performed by persons who, in consideration of the public utility of the work, do it without compensation.* It has been thought that this feature could be embodied in the United States census to a certain extent, or at least supplemented by the employment of school-teachers in the enumeration. The German method involves, of course, the creation of exceedingly small enumeration districts, after the English method, a block in a city or a portion of a street in a town or village being allotted to some patriotic citizen who would without compensation see to it that the schedules were properly filled. It is doubtful if this method could be made useful in the United States. Our people are too busy—at least those competent to take charge of such work—to induce them to enlist. The great difficulty even now is to secure men for a week or a month's service under the Census Office.

The third method of enumeration is that practiced in the State of Massachusetts, and certainly the scientific results of the censuses of that State would indicate the value of the method employed. Since 1845 the Commonwealth of Massachusetts has taken a census regularly, on the mean year of the Federal censuses. It started its census work in 1837 by an account of its manufactures, etc.; but its first enumeration on any broad scale was in 1845, through the assessors of cities and towns. In 1875 the field work was done by enumerators appointed by the census authorities and paid by the day, and they were instructed to secure

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* The History, Theory, and Technique of Statistics, by August Meitzen, Ph. D., professor at the University of Berlin. Falkner's translation.

full and complete results without regard to the time taken. For the population the English method was used, as already stated. The manufactures and agricultural products were secured on individual schedules, statements being certified to by proprietors. In 1885 the card schedule for population was successfully introduced, the other features of the 1875 system and per diem compensation being retained.

Under the Federal system, which I have said is so faulty, all data are collected, so far as population, agriculture, and the general statistics of manufacture are concerned, by enumerators selected by the supervisors and appointed by the Superintendent. The supervisors under the eleventh census are fairly compensated; the enumerators are not. The compensation for enumerating the population under the existing law is in most of the country two cents for each living inhabitant, two cents for each death reported, fifteen cents for each farm, twenty cents for each establishment of productive industry enumerated and returned, and five cents for each surviving soldier, sailor, or marine, or each widow of a soldier, sailor, or marine returned. In some subdivisions the allowance for each living inhabitant may be increased, but the compensation allowed to any enumerator in any difficult district shall not be less than three dollars nor more than six dollars per day of ten hours' actual field work, when a per diem compensation shall be established by the Secretary of the Interior instead of a per capita; nor, where the per capita rate is increased, shall it exceed three cents for each living inhabitant, twenty cents for each farm, and thirty cents for each establishment of productive industry; nor shall claims for mileage or traveling expenses be allowed any enumerator in either class of cases, except where difficulties are extreme, and then only when authority has been previously granted by the Superintendent of the Census. The allowance relative to inhabitants and deaths is the same as under the tenth census. There is an increase of a few cents in the compensation for enumerating farms and establishments or productive industry. It may not be possible nor wise to change this method, but it is possible and wise to make the compensation fair and just. Under these rates it is almost impossible for an enumerator to earn a fair day's wage if he does his duty. In localities where the population is dense, he can earn three or four dollars per day. His ambition is—and human nature prompts it—to secure as many names as possible, and in too many instances he will do this at the expense of accuracy; for accuracy consumes time. Furthermore, he may be inclined, in the very worst localities, in the slums of great cities, to omit, for personal reasons of convenience or otherwise, to enumerate all the people, being contented with taking the population in sight; in other words, two

cents a name might not induce him to enter all the dens of the slums of a great city for the sake of accuracy. In sparsely settled localities even three cents a name (the per capita rate, it must be borne in mind, covers all the multitude of facts called for on the population schedule) will not enable an enumerator to earn a living for the time employed, and he is often inclined to take the statements of neighbors rather than to travel a mile or two to secure accurate statements relative to half a dozen persons. In enumerating establishments of productive industry, the compensation allowed by law will not enable an enumerator, either honestly or dishonestly inclined, to secure any very valuable results. It is quite impossible to fill out a manufactures schedule completely and with fair accuracy for twenty cents. A man could not earn one dollar a day if he did his duty, and on the enumeration of farms he could not earn seventy-five cents a day. The complete agricultural statistics under the census of Massachusetts in 1885 cost about one dollar per farm, instead of fifteen or twenty cents.

The difficulty which Congress would have to meet in adjusting this matter of compensation is twofold. If a very large body of enumerators, like that employed under the elventh census, nearly fifty thousand, should be enlisted on a per diem compensation, the fear would be that there would be men enough in that vast army who would delay their work for the purpose of increasing their earnings to swell the cost of enumeration to enormous proportions, although reasonable accuracy would thereby be secured in every direction. On the per capita basis the question would be whether accuracy should be sacrificed for the sake of a lower cost. The evils of the present system are so great, however, so far as compensation is concerned, and the results of the census vitiated to so large a degree, that it would seem to be wise to adopt a system of compensation which should secure fair accuracy in the results, even at an increase in the expense The country grows so rapidly, and the wealth and business increase so largely, that the total expense of a census should not be considered when the accuracy of the same is at stake.

Another fault of the present system, to my mind, lies in the organization of the field forces. It is perfectly natural that the Census Office, and that Congress, even, should seek a speedy enumeration of the people; but it is submitted that if an instantaneous enumeration can not be had—and it is clearly demonstrable that it can not in this country—then whether it take a week or two weeks, or even three or four, to complete the enumeration becomes a matter of lesser consideration. It might, therefore, be wise to make larger districts and use a less number of enumerators rather than to extend the method by decreasing the size of the

districts and increasing the number of enumerators, as is the present tendency. An enumerator, working for a few days, acquires speed and accuracy as a matter of experience, and his second week's work is of vastly greater value than his first few days' service. It might be well, therefore, to so subdivide the country into enumeration districts that each enumerator would have at least four or five thousand people to enumerate, instead of an average of two thousand, as under the present method. If the districts were enlarged, the number of supervisors should be greatly increased. The present law provides for one hundred and seventy-five supervisors; that of 1880 provided for one hundred and fifty. It would seem to be a prudent measure to provide for at least one thousand supervisors, which body, with a reduced number of enumerators, could take greater pains with all parts of the enumeration; and if supervisors could be selected with special reference to their fitness and enumerators could be tested by the use of a preliminary schedule relating to their own families and perhaps one or two neighboring families, results would be secured which would defy criticism. With such changes there should come a change of date for the enumeration. The count of the people is now made as of the 1st of June—under the present law, the first Monday in June. The changes in the habits of the people necessitate a change of date. More and more every year people leave the town for the country, and this change occurs about the time of the enumeration. The date should be changed to a period of the year when the population is more thoroughly fixed or more thoroughly housed in permanent homes. Could the date be carried forward to the autumn, a great gain would be made in the accuracy of the enumeration—not perhaps in the total for the whole country, but in the total for each State and city. Certainly the results would be far more satisfactory to all concerned, even though the change in the total population of the United States did not exceed a few thousand. Each State wants its own: political and social reasons demand that this should be so.

Perhaps the very worst form of the present system is the temporary nature of the service. As the census year comes in sight each decade, a Census Office is created by law, the organization to be taken entirely from new material, from the head to the foot. Of course, the aim always is in securing a superintendent to select some one who has had more or less experience or is supposed to be more or less competent in census work; but then comes the greater difficulty, the selection of the forces. A good business man at the head of the Census Office—one of excellent administrative and executive abilities, without knowledge of statistics—would handle a census, in all probability, as well as or better

even than a statistician without business qualifications; but the organization demands skillful men at the head of divisions and skillful and trained statisticians as assistants. Every superintendent endeavors to draw into his service a certain number properly qualified, statistically speaking, for the service required; but everything must be drawn together hurriedly—a great bureau, the largest in the Federal Government, created in a brief period, and the work carried on with the greatest rapidity. With the vast expansion of census inquiries, in connection with the necessarily speedy organization, it is absurd, without regard to the qualifications of the head of the office, to expect valuable results for the money expended. It is not in the power of any superintendent, no matter what his experience, no matter what his qualifications may be, to take a very satisfactory census under the conditions involved in our Federal system. The attempt is made to create a vast official machine, and then to at once collect material involving in its collection answers to thousands of inquiries by a force of nearly fifty thousand men in the field and an office force of five thousand, the whole work to be completed within a year or two, and the data to be collected under a system of compensation which does not allow, or certainly does not induce, accurate work. The result is that the Census Office is, within a few months after the date set for enumeration, literally "snowed under" with raw material collected by crude and, in a large majority of cases, inefficient forces, to be digested and compiled for printing by another force nearly as crude as the field forces. It is not in the power of human capacity to carry out scientifically the work of the Federal census. It never has been done; it never can be done until the system is changed. This does not involve any criticism as to the growth of the system nor of the men who have so ably administered it. The point I make is that the census system has grown to be unwieldy in natural ways, and that it is time to correct it, and the very first step toward correction lies in the direction of the establishment of a permanent Census Office, under which there ought to be a constant force of trained and experienced statistical clerks, and the collection of facts distributed over the ten years instead of being crowded into a few months. This change of itself would correct many of the faults of the present system. The facts relating to population and agriculture might be collected in the fall of the census year, when the new agricultural crops would be considered instead of the old, as under the present system, and then the data relating to manufactures and all the other features necessarily involved in the census could be taken up year after year and carried each to a successful conclusion. This would involve the employment constantly of a much reduced office force, and a field force, except for the enumeration

of the population, gradually becoming more and more skillful. The expense during the whole ten years would be somewhat larger than is now involved, but the results would be of such infinitely greater value that the increased expense would not be a matter for a moment's consideration. My suggestion, then, for future census work would be, first, a permanent Census Office, involving an efficient field force, under the most liberal provisions as to supervision, and an organization of an office force so adjusted that it could be made elastic and yet preserve the functions required to secure accuracy and completeness; second, an adjustment of compensations for field work that would secure complete and accurate returns in all the departments of census work.

It may be argued that there would be nothing for a permanent Census Office to do a great part of the time. In answer to this it can be said, that if the regular work of the census should leave the force in comparative idleness, it might be employed in tabulating some of the results of previous censuses which it was found necessary to abandon; for instance, in 1880, although the facts were secured by the regular enumeration, no tabulation was made of the single, married, widowed, and divorced. The questions now agitating the public mind relative to marriage and divorce are only half discussed, because the facts for the whole country can not be ascertained. This is only one feature. A tabulation of the facts relative to conjugal condition, as indicated, for the year 1880 would be vastly more valuable, even now, than it would have been in 1880. And so of other features. By picking up such abandoned results, a reasonable force in the Census Office could be constantly and profitably employed, with increasing skill, so that when the results of new enumerations came into the Census Office, a trained force sufficiently large to influence the whole body of new appointees would be in readiness.

If, in addition to the changes suggested, the several States could be induced to co-operate with the Federal Government, a great advantage would be gained. The States might undertake the collection of the statistics of population, manufactures, and agriculture on as extended a basis as individually they might choose, but guaranteeing to furnish the Federal Government with certain clearly defined and uniformly collected data, for which the Federal Government should provide reasonable compensation. Under some such adjustment the statistical work of the United States Government and of the individual States could be brought to a very high state of perfection, with the burden of expense so divided and adjusted that it would not be considered as a stumbling-block in the way of progress.

One of the most encouraging movements of the present day is that of the trade and business organizations of the country to

secure a perfected and scientific statistical service in this country. This movement commenced during the closing days of the last Congress, through memorials from boards of trade, presented by the National Board of Trade, asking that the question of the establishment of a permanent Census Office be considered by the Secretary of the Interior and a report made to the Fifty-second Congress. The matter is therefore open for consideration by the public and by Congress, and, whether a permanent statistical service is provided for or not, great good must come from the discussion, and ultimately the faulty features of the present system be removed.

REEF-KNOT NETS.

By WILLIAM CHURCHILL.

AT the bottom of textile industries net-meshing appears to precede even such simple weaving as the making of mats of grass and bark. Not only is it the earliest of the textile arts, but it is even more prominently an unchanged art through all the stages of development which have culminated in the Jacquard loom. Ancient or modern, laboriously made by hand or the product of intricate machinery, the mesh knot is practically unmodified in the nets of the steam trawler and the naked savage. It seems, indeed, one of the few contrivances of human ingenuity which came early to perfection and have not proved susceptible of any improvement in all the succeeding ages.

It may, then, be not without interest to present a radical variant of the common mesh knot as noticed in general use among a considerable people in the western Pacific, together with such notes as are available to show a wider distribution of this knot.

In western New Britain, on the coast of Dampier Strait, facing New Guinea, where the Papuan characteristics are most strongly impressed upon the Melanesian type, the writer noticed the netting of a large seine and was attracted by the unfamiliar motions of the old women engaged in the work. Closer examination disclosed the fact that every knot in the mesh was of the sort known as the reef or square knot, in which the four ends come out in pairs, each pair on one side of the bight or loop of the other pair. As nothing could be more widely dissimilar from the ordinary mesh knot, an effort—and a successful one—was made to induce the netters to communicate their art, which is here presented with figures which may aid to a clear comprehension of the method of manufacture employed. These figures give a view of a net in process of construction, with detailed drawings of the foundation knot and of the successive stages in forming the mesh knot.

Besides the netting-cord (commonly *coir*, the fiber of the cocoa-nut husk, which is very durable in the water), the only tool used is the mesh-block (E, Fig. 4). This is a thin block of hard wood rasped into shape, and, since these tools are treasured as heir-looms, together with interminably long rhythmical recitals of the wonderful takes of fish made by nets fabricated on each block, the wood most commonly employed is the very dense and hard iron-wood (*Casuarina equisetifolia*). It is highly polished and usually ornamented upon the ends with property marks, showing the exogamous marriage class and *gens* of the owner, which here take the place occupied by tribal distinctions among the endogamous races. The blocks are commonly of uniform size. Their length, which is practically a constant quantity, is determined by the length (about five inches) which may be held between the extreme tips of the fingers and the ball of the thumb, for that is its position when in use and to secure it against slipping the edges are carefully brought to a true right angle. The height of the block is, of course, determined by the width of mesh desired, but a height about equal to the breadth of the hand across the palm is most frequent, since the mesh made upon that gauge is found most satisfactory in taking the fish usually seined for. In width the blocks seldom exceed a half-inch, and have an oval section. Smaller hand-nets, in which accurate meshing is not desired, are commonly knotted over the finger with much nicety.

The net is started on pegs driven into a beam, corresponding in number with the number of meshes in a tier which it is desired to put into the net, and these netting-beams are a prominent feature on every village green. At a distance from the end of the cord somewhat greater than the proposed width of the net, a bowline knot (A, Fig. 4) is turned in and cast upon the first peg toward the right. The two unequal parts of cord issuing from this knot may, for the sake of distinction, be denominated the ball part and the free part. The latter is carried taut to the second peg, and there stopped close to the beam by a light lashing, and at the top of the peg is passed into an eye or narrow cleft. The mesh-block is now laid against the row of pegs; the ball part is passed first below and then above it from the bowline knot to the second peg, forming the first half-mesh (B, Fig 4); it is then cast over the second peg, and the free part of the cord attached thereto with a pair of half-hitches (C and D, Fig. 1). The free part is then withdrawn from the eye in the peg, drawn taut through the two half-hitches, and half-hitched back upon itself (E, Fig 1). It is now carried from the knot just formed (C, Fig. 4) to the next peg and there made ready for further use; the ball part is again carried around the mesh-block and hitched and bound as before. Upon the last peg in the row this knot is made,

and in the remainder of the free part close to the peg there is turned in a second bowline knot (D, Fig. 4). These two bowline knots serve as clews to the net. This selvage and first tier of half-meshes are invariably made from right to left, on the ground that it is the custom of the country, and any variation therefrom would be attended by consequences as unpleasant as they are ill-defined.

The second tier of meshes is made from left to right, and here the peculiar mesh knot makes its first appearance.

Holding the mesh-block in her left hand, so that its upper edge just touches the bottom of the meshes already formed, the operator passes the ball of cord from the last knot down in front and up behind the mesh-block (F, Fig. 4), making due allowance for the difference in size of this exterior mesh necessary to keep the tier uniform. The ball is held in the right hand, gripped between the ball of the thumb, the palm, and the third and fourth fingers, thus leaving the thumb and two fingers free to work

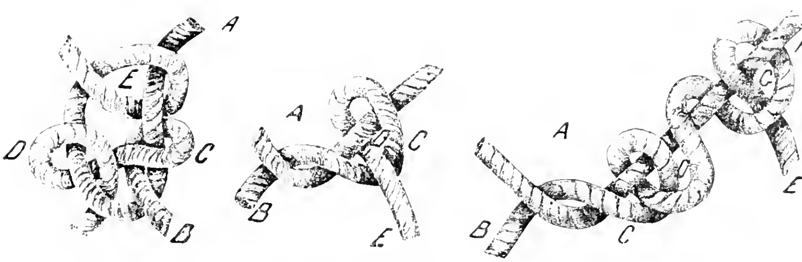

FIG. 1.—SELVAGE KNOT. FIG. 2.—MESH KNOT, FIRST TURN FIG. 3.—MESH KNOT, SECOND TURN.

with. A loop (C, Fig. 2) of any convenient size is made in the netting-cord, between the block and the ball, passed up through the bight of the mesh (A) from below, and drawn through the bight sufficiently far to draw taut the part which passes about the mesh-block, in which position it is stopped by the left thumb on the block. The ball (E) is passed through the loop (C), also from below upward (as shown at D), returned to its place in the palm of the right hand, and the part drawn taut and stopped by the left thumb. This completes a single turn of the knot as shown in Fig. 2, where the relation of the several parts is exhibited before they have been pulled taut and stopped, which in practice will be found essential to the success of the operation.

The second and final part of the knot is illustrated in Fig. 3. A second loop (F) is made in the cord between the ball and the part stoppered by the left thumb. This loop is passed from above downward through the bight of the mesh (A), drawn taut, and stopped at the mesh-block by the left thumb as before.

Through this loop (F) the ball (E) is passed also from above downward (as shown at G), and pulled taut to the left thumb, where the knot is felt to turn part way around, and is found to be a perfectly formed square knot as shown in Fig. 4, at G.

This second tier of meshes completed, the operator shifts the ball to the left hand and the mesh-block to the right, and makes the third tier from right to left. The final tier with its clews and selvage are made by reversing the process described for beginning the net.

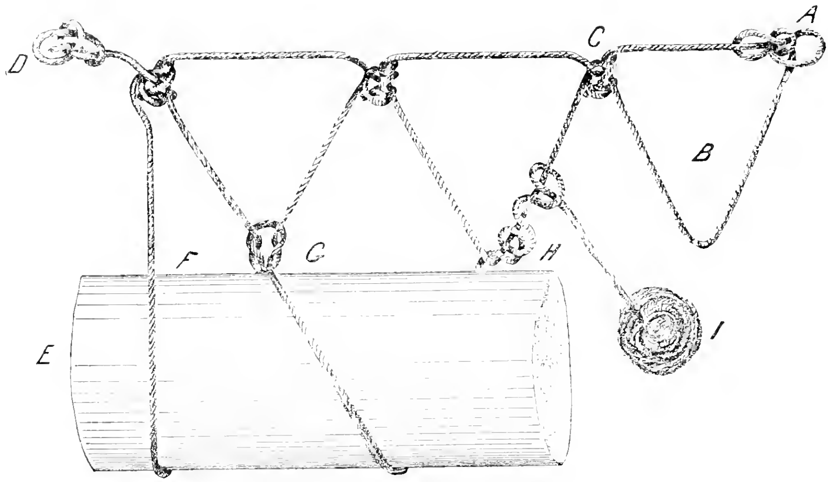

Fig. 4.

This method of meshing, though unfamiliar, has several distinct advantages over the more usual method; of which one inheres in the knot itself, two in the line of greater simplicity in the mode of manufacture, and one in the possibility of easily producing irregular designs for particular purposes—that is to say, of netting pockets and pounds without interruption of the thread.

The advantage in the knot is one which will immediately be apparent to those who have given attention to the study of knots, for the reef knot is incontestably the simplest and most secure means of joining two parts of cord. The advantages in the mode of manufacture are that one implement, the netting-needle, is dispensed with, and that the net may be made of a single cord continuous throughout, and thus is of equal strength in every part. It would be tedious to go into the details of making pounds and pockets in a net; it is more simple than appears, and the thread continues without a break through the net and insert-piece as well. It is possible that some one skilled in mechanical arts may find in this device the suggestion of a mode of simplifying the machinery at present used in the manufacture of nets for commercial purposes.

In connection with the several obscure but remarkable instances of correspondences between the American shores of the Pacific and the remoter islands of Melanesia, it is interesting to note that the only other well-defined discovery of this mesh was made in British America upon the Pacific shore. Prof. George Davidson, of San Francisco, a most accurate student of the life of the native races with whom he had to deal, in prosecuting the survey of that coast, found nets of this peculiar mesh manufactured by the Tchin-cha-au Indians of British Columbia in the vicinity of Port Simpson, and described it in the proceedings of the California Academy of Sciences, of which body he was for many years the president. The writer has been informed that a similar mesh has been noticed in the textile remains of the lacustrine period of Switzerland, but he has been unable to identify the reference in any of the figures contained in the usual authorities upon that prehistoric society.

THE ETHICS OF CONFUCIUS.

By WARREN G. BENTON.

IN former papers on the Chinese religions I referred to Confucianism as a religion, following the generally accepted view of the matter. But in this paper I shall treat it as in no legitimate sense a religion, but simply and purely a system of moral or ethical philosophy.

Religion has to do primarily with the existence of a deity and with the question of man's immortality, and the relationship existing between the two. Morality may grow out of man's effort to sustain an acceptable relationship to the Deity and the future life; but if so, it is incidental to and not a part of religion. The ages most noted for religious enthusiasm, and in which human life and liberty were most freely sacrificed for orthodoxy in religious opinions and forms, were notoriously immoral. And at the present day, in many countries, the most religious are not the most moral communities. At Panama, a few years ago, I went to a cockpit on a Sunday afternoon, and among the spectators were several gentlemen in clerical cloth; and after the various battles were ended I observed that these clerically clad gentlemen were exchanging coin on the result. During the same afternoon, while "taking in" the sights of that town of cathedrals and churches, I saw more than one woman, around whose neck was suspended an image of the Virgin Mary, but whose manner of life indicated that a less appropriate symbol could not well be imagined. It is equally significant that rarely does a criminal ascend the gallows

in this country that he is not accompanied by a clergyman, and he dies with the professions of piety and religious faith on his lips. Our penal institutions are filled with religious believers, and it is rare, in fact, that such men are not nominal members of churches, or at least have been at some time in their lives. I do not mention this fact to intimate that religious education or belief tends to promote immorality, for it does not; but rather to show that religious belief does not necessarily promote morality, no more than does the absence of such belief tend to promote immorality

If a system of ethics and morality founded upon a purely human basis, and having no reference to any deity or future life whatever, is a religion, then Confucianism is a religion. But I do not know of any definition of the term that would include such a system.

The simple assertion, by those claiming authority on a subject that lies beyond the sphere of demonstration or proof one way or the other, has either to be accepted as a fact or repudiated as not proved. In the realm of religious dogmas it has been held to be good logic that when a proposition can not be disproved that it stands as proved. By this logic religions have been established. But in the matter of ethics the case is different. This comes within the scope of experience and demonstration, and is the outgrowth of experiment. There is no absolute standard of morality, what is construed as such being a relative condition, and regarded as good or bad, according to the state of civilization and educational standard by which actions are measured. What is regarded as perfect conduct in one age or under one environment may be rightly condemned under a higher development of the moral sense as a feeble attempt at morality.

What is called conscience can not be set up as a guide in the matter, for it is but the result of the *mode* of education. One man's conscience will approve of a given course, when another under a better social and political education will repudiate it as vicious. Among the lower orders of savages and uncivilized men there is apparently no moral standard observed. With the lower animal kingdom questions of priority and individual rights are settled, not by any tribunal in equity, but by the measure of physical strength. And what are considered the cardinal points in moral and ethical systems, as set forth in the decalogue of the Jews and in the corresponding codes of other ancient religions, are but the embodiment of the results of experience in the earlier developments of civilization When men first began to acquire property by industry or cunning, they found it inconvenient to have others appropriate the results of such thrift, and perhaps the first moral obligation recognized was the right to property;

and the law against theft was among the first formulated codes: "Thou shalt not steal." Before such institutions as police courts were evolved, the only tribunal for adjusting personal difficulties was to fight it out; and the stronger combatant, other things being equal, was proved in the right because he vanquished his foe. But, as societies or community of interests began to be formed, it was found better to have boards of arbitration to settle disputes, and, as is shown in the controversy over the ownership of a certain herd of cattle in biblical times, the method of settling intricate problems partook largely of the plan of tossing up of pennies, yet it indicates that progress was being made over the fighting era. "Thou shalt not kill," especially a fellow-tribesman, was an early section of the moral code.

The custom of mating which obtains among many species of birds and some quadrupeds, and which, as man advanced in civilization, resulted in the establishment of the marriage relation, led to the edict against adultery. As tribes increased in numbers, it was found necessary for purposes of offensive and defensive warfare that some sort of organization should be observed, and this implied a division of labor and function. Political organization implied that some one or more of each tribe be designated to direct the operations of the rest, and the greatest warrior was naturally selected as the first chief; and the first chief used his power and position to install his sons as his successors, and thus were the first royal families evolved and succession to rulership established. National or tribal lines of jurisdiction followed the introduction of agricultural and breeding pursuits, and states and national boundaries were surveyed or designated. Territorial limits being established, tribunals or international bodies were necessary to regulate conflicting interests. The first resort was the war-club, and the enslavement of the vanquished. This method of arbitration has not yet been fully eliminated, but progress is being made in that direction, and international tribunals for arbitration now endeavor to supersede the sword.

Thus were governments evolved and written constitutions and statutes enacted, and codes of laws with penalties for restraining the criminal classes from violating the rules experience has found to be essential to good government and good society. None of these primary laws have been created by the makers of religions, but all such have found these in force wherever man has reached a sufficient degree of civilization to receive a religion.

This is why in all the various systems of religion we find the same essential basal moral laws inculcated. One has not copied from another, as is sometimes asserted. The fact that the same moral laws are found in two or more systems of religion does not indicate that the younger has copied the older, but that both ap-

propriated existing well-defined and primal elements of moral law which had been evolved in preceding ages.

Confucius followed this principle, and did not lay claim to having originated the principles of his philosophy, but to have simply undertaken to revive laws which the ancients had laid down, but which had become practically obsolete through non-observance. He undertook to induce his fellow-men to observe the essential laws of good government and good society, not because of attached penalties, but because it was necessary to good society and the promotion of virtue. He recognized with sorrow that political intrigue, infidelity to the trusts of men in all relations, and crime of all kinds prevailed in spite of the laws intended to regulate such things, and to the task of restoring the righteous rules of his ancestors he set himself. He knew that penal codes were powerless for good when there was not a moral sense to enforce them. Modern prohibitive legislation is a parallel case.

All the prohibitive statutes that our Legislatures have so far enacted have failed to do away with drunkenness, for the reason that there is lacking sufficient personal sense of obligation to enforce them. The Chinese statutes, or the writings of the fathers, the classics so called, set forth the means to virtue and morality; but neither the legal authorities nor the people recognized any need for enforcing or observing them. He sought by precept and example to revive the moral sense of the people; but at the end of a long life he died in poverty and disappointment, having apparently produced no impression.

Kung-fu-tse (Latinized into Confucius) was born about 550 B. C. His father was descended from one of the many royal families which had figured in the past as rulers of tribes or provinces. Most likely these ancient Chinese royal families were little more than the Indian chiefs in our day, and their claim to royalty was recognized only in a very narrow limit. But he was not in power when the Sage was born. He had been married two or three times, but had no son, except one cripple, which did not count. At an advanced old age he married a young wife, and Kung, Jr., was the result. The father died when the boy was about three years old, and left his family in poverty. But, under the class distinctions into which Chinese society was divided, Kung inherited at least the class instincts of a gentleman, and managed in some manner to obtain a good education as Chinese education went. He was married when about twenty years old, and soon after his marriage his mother died. According to the custom of his country, this event required that he retire for three years from all business relations, and it is supposed that he spent this period of mourning in the study of the classics. When he again

appeared in public he engaged in teaching school for some years; but, being imbued with the desire to effect a reformation among his people, he gave up teaching and sought and obtained employment in a government position under the ruler of his native province. His life as a civil officer enabled him to observe the methods of official conduct, and still further intensified his desire to restore a more righteous rule. He decided to seek the co-operation of some one of the many claimants to royal prerogative, and, by enlisting such sympathy, he calculated that by inaugurating a model reign, under whose influence men would turn again to the correct paths, he would absorb all contiguous provinces, unify the government of the race under a common flag, and see virtue and peace again among men. But he failed, after wandering from one province to another, to enlist the sympathy or co-operation of any one in a position to assist him; and he eventually gave up in despair, and, gathering a small following of disciples about him, he retired from public view, and passed the remainder of his days in teaching his chosen few and lamenting the evil days upon which his people had come. To fully appreciate the great task he had set out to accomplish, the reformation of China upon a strict ethical basis, it is necessary, as far as possible, to picture the condition of his people at that time. If we allow for some advance in civilization during the past twenty-five hundred years, and contemplate the China of our day with what in his day it must have been, we must concede that he had a very unpromising, crude material to work upon. From what he wrote on the condition of things, and also from the writings of Mencius a century later, we conclude that it was indeed a dark picture for the idealist to contemplate. Mencius states that in his time men had reached a state of degradation in which they denied that there was any distinction between good and evil, virtue and vice. All moral restraints were thrown off, and public or private morality was unknown. But, notwithstanding the philosopher was dead, his name and writings still existed, and had their influence on a few minds. Among these was Mencius, who seems to have been a more able man than Kung himself, and who espoused the cause of reform. He was wise enough to see that nothing might be hoped for in the way of co-operation of the rulers, who were as bad as the common people, but he set to work to gather and put into form the writings of Kung-fu-tse. Perhaps but for this work the very name of the Sage would long ago have been forgotten; for his writings were left in a fragmentary and scattered shape, and even do not take high rank in point of literary merit. The Confucian Analects, as compiled by Mencius, and with added comments by the latter, have been translated into English by Rev. Mr. Legge, an eminent Oriental scholar, and the

work comprises in many large volumes about all that is known of the writings of the Sage.

The bulk of this extensive work consists in obscure allusions to things no doubt familiar in his time, but now obsolete; and in meaningless fine distinctions and references to the "Rules," "Forms," and such things that have but little significance to the modern reader. But the gist of the matter may be summed up in one short sentence: "Walk in the old paths." And when we come to define the old paths we find what he called the "Five Relations," under which he defines every known duty of man. These "Relations" had been defined and enforced ages before, in the books called the Classics, perhaps for the reason that they were so old that no one knew when or by whom written. It is these five propositions that have called forth dozens of folio volumes to elucidate and enforce. And it is these that constitute what is known as Confucianism, although he never originated them nor claimed to be other than a teacher of the faith of the ancients.

These five relations have in them an entire code of political and social economy of the highest order.

First Relation; King and Subject.—Kung, in harmony with the established form of government under which he lived, was an advocate of absolute monarchy. The fact that he had a tinge of royal blood in his own body may have unconsciously influenced his judgment on this point. At all events, he left no indication of any disapproval of the system. He favored paternal government, both for the nation and in the family. The patriarchal plan has always been followed out in China to the fullest detail. The Emperor is as the father of the big family, and there is no appeal from his authority. The question of how the reigning monarch attained his position is not taken into consideration. The fact that he is on the throne is sufficient to secure the most absolute and abject obedience to his mandates. Kung set forth certain wholesome rules which should control his actions in the belief that the subject as well as the ruler had rights. He sought to supersede kingship by force with kingship by fitness. The civil government being a counterpart to the family government, the rules or principles obtaining in one should be equally applied in the other. The subject should love the king as the son loves the father, not for the enemies he might have made, but because of a righteous administration of the affairs of the country. He gave no countenance to a divided household. No rival political parties, appealing by bribes of office, nor threats of non-support at the next election, could disturb the serenity of the rulers or ruled. No penalties for treason, where a government was so good that none could find fault, were needed; and, in the event of individ-

ual remonstrance, the recalcitrant was to be dealt with as a father would treat a disobedient son. The rod has always been the chief instrument of enforcing discipline in the political household as well as the domestic household; and cases that will not submit to this primitive method of chastisement are visited with the guillotine.

The fact that no one could be found willing to undertake to put in force his method of conducting government is due to the strict conditions he sought to enforce. Rulers were accustomed to hold the people in check by force of arms, and subaltern petty officers were appointed by the crown and held their position by carrying out the desires of their creator. Confucius declared that political appointments in the civil service should be made on the basis of individual merit, rather than simply the standard of subservience to the dictation of the throne. He was the first advocate of civil-service reform, and his success in that line is not calculated to create very high hopes in those of our day who would substitute a similar test for office.

It is commonly understood in this country that China has long practiced competitive examinations of candidates for office. They do go through such a form, but it is a mere farce. For appointment to a position in the customs service, for example, the examination is conducted by testing the candidate in his proficiency with the bow and arrow, and by having recitations from memory of certain portions of the classics. The man who can hit the bull's-eye the greatest number of times in a given number of shots with the bow, and can recite the greatest number of pages from some book, of the meaning of which he may be utterly ignorant, is considered the best fitted for the position. It may be that they consider that a man who is skillful with the bow, and whose memory will absorb a long list of trite sayings in a book, will also be capable of acquiring useful knowledge in his chosen position in the civil or military service; but certainly the attainments tested are of no practical benefit in the work to be done. Running and jumping and other athletic attainments are also tested. This is more useful, especially in the military service, than the other tests appear to be. A good runner in the army may be an important foresight in the selection of soldiers or officers who are thus selected. China's experience in her recent wars with European armies has taught her the need of a fleet-footed soldiery to enable them to get out of the way of the enemy.

It is, of course, difficult to estimate what part the teachings of Confucianism have had in forming the national character of the Chinese. Some powerful influence must have been required to secure such a condition of contentment under such an arbitrary government to hold together in apparent submission to one reign-

ing house for so many centuries. True, that country has been the scene of many bloody civil conflicts in her history. At the time of Confucius the country was not, as now, one united empire, but was divided into many smaller jurisdictions. The political unity of China was brought about several centuries after his death, and was the result of a long period of tribal or provincial conflicts.

Then later the Tartars subjugated China, and absorbed the original China proper, as it is spoken of, into the present boundary, and the Tartar dynasty has held the control of the government ever since. The only attempt of any importance made since that conquest to restore Chinese rule was the Taiping rebellion. This revolt promised to be successful, until the British and French Governments interfered in aid of the Tartars, and under Chinese Gordon put down the rebellion. Now every precaution is taken to prevent another rebellion. Guns and gunpowder have been declared contraband, and are not permitted to the ownership of the natives.

The Chinese contingent in the army is equipped with bows and arrows, spears, and old-fashioned muzzle-loading blunderbusses of the most primitive pattern. All native regiments are also officered by Tartars, and Tartar regiments are equipped with modern rifles, and drilled under European tactics, to give them an advantage in the event of any future uprising.

Local magistrates and governors of provinces and districts are all appointed by the Emperor, from the Tartar contingent, and hold their offices at the discretion of the throne. They assume to judge of what is beneficial, and decide the policy of the Government entirely on their own judgment, without consulting the wishes of the populace. There is no appeal to the people for approval or disapproval of the Government's action on any subject. The masses submit to the inevitable, not apparently so much from any recognition of wisdom in its administration, but rather as an inevitable result of their inability to help themselves. Taxation is laid in a most summary and arbitrary manner, and collected by the officers appointed for that purpose, and there is a continual struggle between the tax-collectors and the tax-payers to try to outwit each other. Duty is assessed upon every article of domestic production, as well as all imports. Farm products have to pay duty at every thirty miles they may have to traverse to reach a market. A cargo of tea leaving Hankow for the seaboard for export, if carried in native bottoms, must pay taxes every thirty miles of the distance. Under treaty stipulations, cargo carried under foreign flags is assessed only at the point of departure. This has created a lucrative business for many Americans and others, who ostensibly buy boats and cargoes, and fly

the American flag over them, for a fee from the real owners. Merchants of all classes are taxed five per cent on gross sales, and have to submit their books for inspection freely to the tax-collectors; and detected efforts to get around the tax, other than by bribing the collectors, which is not at all difficult to do, results in the confiscation of their entire possessions. Once I witnessed the novel transaction of a foreigner who wanted to purchase a milch-cow, and the farmer drove the cow to the outside limits of the tax station on the outskirts of the town, and tied her there and came for the buyer to accompany him outside to complete the purchase. He could pass the cow without taxation, but the native owner could not. This is why the Chinese in California show such skill and fertility of resource in smuggling in opium. Their past training in subterfuges to beat their own tax-collectors has trained them in the business. And they do not regard it as any crime to beat the Government if they can. In this freak they are not wholly unlike many of our own race, as our custom-house officers are aware.

We can not, of course, determine what would have been the condition of China, in the matter of the relationship between ruled and rulers, had Confucianism never impressed its doctrines on the subject, but certainly he has not achieved any striking success in this first of the five relations.

Second Relation: Husband and Wife.—The husband is regarded as holding much the same relation to the wife as the Emperor to the people—that is, he has absolute authority over her. But that authority must be exercised with justice and sympathy. The wife shall obey the husband, but he must be worthy of obedience. Polygamy is now practiced in China, but it seems not to have been at the time of Confucius. At least I have observed no reference to the matter in his treatise on the second relation, which seems probable would be the case if it was recognized at the time he wrote. His plan elaborated the most minute provisions for the conduct of married people, and, were his ideal carried out, a most happy state of married life would result; but, judging from appearances, he has more signally failed on this point than on the first relation. Chinese marriages are not conducted on the plan most conducive to harmony. Their matches are not made in heaven, as poets sometimes declare of this matter, but in a broker's office. They are not the result of a personal courtship between the parties to the compact, but are a matter of barter and sale. Fathers negotiate for wives for their infant sons, and infant betrothals are in reality infant purchases. Both husband and wife being entirely passive in the matter, there can not be anything approaching to personal attachment between them. Marriage being a matter of purchase, there is no provision

for divorce required. If a husband is not pleased with the wife, he can sell or trade her off. If the wife is not satisfied, she can drown herself. The so-called slavery of women in Chinese communities in this country is simply the lawful marriage arrangement of that country. It sometimes transpires that women bought as wives are treated as merchandise, which they really are as a matter of fact, and are subjected to immoral and degrading uses. This is especially the case in this country, where the women are few in comparison to the number of men of that race. In China women are treated with perhaps as much consideration as in other countries. They are not accorded full recognition as the equal in rights with man, but there are those even in our own country who declare that this is true of our women also. In China they are not treated as being personally responsible for their position in society, and are guarded with a more jealous care than with us. Here, a wife or daughter, growing weary of the restraints of the home, may go to another city, change her name, and enter upon a life of entire freedom from all restraints with impunity. With them it is impossible. Women there sustain more the position of domestic animals, which have a material value, and, if they stray from home, some one is interested in looking after them, much as an estrayed horse or ox. It is a matter of fact that, from whatever cause, there is not to be found in Chinese cities the class of abandoned and immoral women as in all European and American cities. The laws of the land forbid them, and their laws are more strictly enforced in this regard than in any other country I know anything about. Polygamous marriages and the concubinage system prevail, however, and, while this may be as bad as the other, it is not so apparent and obtrusive upon the public notice as are the Whitechapels of London or New York. But, view it as one may, it is apparent that the condition of Chinese women is far from what Confucius thought it should be.

Third Relation: Parent and Child.—In this relation the greatest stress is placed upon filial obedience. Under the patriarchal family economy, the eldest male living is the acknowledged head of every family, even though the family, as it often does, contains three and four generations. The father of the family is the established authority on all matters of policy in business and otherwise, yet each son owes special allegiance to his own father. Nor is this duty ended with the death of the father, but is perpetual. Once a year the grave must be visited and the little mound rebuilt and kept in repair by the dutiful son. The wine and food that are left by the grave in connection with this ceremony of rebuilding graves are not a part of Confucianism, but the point of contact with Taouism. This custom of

honoring the dead has created the impression among foreigners that the Chinese worship their dead. "Ancestral worship" is commonly spoken of as an established fact; but it is entirely a mistake. They do not worship their dead in any legitimate sense. The ceremony of restoring the graves is not unlike in nature and answers much the same sentiment as our annual ceremony of decorating the graves of our soldier dead. We strew flowers upon graves and construct monuments in marble or bronze over the tombs of our distinguished dead, and yet we do not worship them. If a Chinaman, witnessing these observances with us, wrote to his friends that the Americans worship their dead and erect idols over their tombs, it would be a similar error to that we perpetuate in our books regarding the Chinese ceremonies in honor of their dead. Ancestral tablets are hung upon the walls of Chinese homes much as painted portraits are upon ours, not to be worshiped, but to keep in perpetual memory the departed. The desire to be thus honored after death is why Chinamen are so anxious to leave sons. It is also why those dying in foreign lands are so careful to have their bones taken back to their native homes. They wish to be remembered when they are gone, and only sons—dutiful sons—will see that the graves of their fathers are kept green. It is the most striking feature of Chinese character—their great respect for their fathers. In all business enterprises, in poverty or in wealth, the Chinese look to their fathers for counsel and example. This amounts with them to a positive passion, and is the greatest obstacle in the way of the introduction of modern methods and appliances. What was good enough for their forefathers is good enough for them. If anything new is offered, they dismiss it with the belief that, if it had been necessary, their fathers would have had it. They are not an inventive people, and use to-day the same pattern of plow and hand-made goods of all sorts they did a thousand years ago. The same cut of coat, build of boats, architecture, everything remains now as it was at the time when history with them first began. Filial affection is deep-rooted in their natures, and no one questions the propriety of it. Here, at least, Kung has impressed himself upon his people.

FOURTH RELATION; BROTHER TO BROTHER.—The patriarchal plan of family government leaves but little scope for individuality in the members of a household. Estates are entailed from one generation to another intact. All the members of a family partake of the resources in common, and are supposed to perform their share of the labor. But they own nothing in severalty. This removes the most fruitful source of fratricidal conflict. No quarreling over division of property, and no cutting off of one in favor of another heir at law, for all remain in equal possession of

the property, and each subsists upon a common treasury. All the sons work in the same business, shop or store, with the father. This is why for a hundred generations the Chinese follow the same calling. A shoemaker's sons are shoemakers, for the reason that they are put to work at the bench as soon as they can drive a peg. Shifting from one employment to another is rare with them. They do not take freely to learning a new trade, because, if they have any property in the family, it can not be divided and sold by the heirs, unless the sale is by consent of all the heirs, and then, of course, a mutual distribution is made. In business pursuits, the profits of the enterprise are not drawn out by the members of the firm, which in almost all cases means the family; but, after meeting current expenses, the accrued surplus goes into the accumulated assets. Thus, unequal wealth is not a source of family quarrels. I never knew two brothers where one was poor and the other rich. They are all poor or rich together. The trait, thus developed, of intimacy between brothers and all members of the household has left its imprint upon Chinese character in general. Clannishness is one of their national marks.

Fifth Relation; Man to Man.—In this proposition is the province of ethics. It is a far wider field for the philanthropist and reformer to deal with than any of the foregoing. Here all ties of kinship and fear of authority are removed, and the question of the equality and rights of man comes in. The same sentiments in our Constitution are lauded as the climax of humanity and civilization. The same sentiments were promulgated by a pagan philosopher five hundred years before the Christian era; and he founded his arguments upon what had been written so long before his time as to be ancient history.

Men have always been in each other's way Conflicting interests of tradesmen and fellow-workmen of the same crafts always have and always will exist. The harmonious co-operation of Bellamy will probably require more than twenty centuries to materialize. Labor unions seek to regulate the matter by restricting apprenticeships. Merchants try by underselling each other to drive the weaker ones to the wall. Manufacturers and capitalists enter into trusts, hoping to freeze out the smaller competitors and destroy competition. But all alike fail of their purpose, and conflicting interests as old as the human race itself continue, and always will, in all likelihood. In times past unwelcome competition was checked in a more violent manner. Walking delegates and boycott committees were armed with daggers and clubs, and the stronger tribes annihilated the weaker ones or enslaved them. It is certainly a high testimonial to the pagan reformer that he sought to inculcate the doctrine that one man had any rights that another was under obligations to respect.

The golden rule of the Christian religion is regarded as the climax of excellence. Five centuries before Christ, Confucius wrote page after page to inculcate this same principle. One half of the decalogue of Moses is devoted to enforce the rights of man between man. Thou shalt not steal, nor bear false witness against thy neighbor, nor covet anything that is his. One man shall not tear down or injure another, in order to promote his own interests, is a doctrine hostile to the nature and practices of men in all ages, and yet a principle essential to the perpetuity of governments and social progress. Animals by instinct devour and destroy each other in their pursuit of life. Men in uncivilized states do the same thing in effect; and it is quite clear that we have not yet fully outgrown the animal instinct in this direction. But we all understand that it is right to do so, and, if we do not, we at least pretend that we do, and only eat each other metaphorically.

Nature has wisely provided that, when a man has lived for a few years, he shall give place to his successors. But as long as one remains on the earth, other things being equal, he is entitled to life, liberty, and the pursuit of happiness in his own way, provided his way does not interfere with the rights of others. There is room on the earth for all that are likely to occupy it at any one time, and, when the numbers reach an excess, disease or famine or war relieves the surplus. And under all circumstances every man should be protected in his life and interests from unequal advantages being taken of him by his neighbors. So taught Confucius. So teach all systems of sound social and moral philosophy.

In conclusion, I wish to say that, judged by what it has probably accomplished, the Confucian system has done much toward creating whatever of good is found in Chinese character and institutions; and what it has failed to accomplish is not due to any defects in the system, but rather to the inherent tendency in human nature to seek its own way. Men have been slow to ask what is the better and wiser course to pursue, and have inclined to follow their more brutish instincts.

At the present day, however, Confucius wields but little influence over the Chinese. In most cities are temples, or, more correctly speaking, halls known as Confucian halls. They are entirely void of any appearance of idolatry. His name is revered as a wise and good man, but he is not worshiped, nor has he in any legitimate sense been deified by the people. As Washington in America is venerated as the father of his country, and as Abraham Lincoln is spoken of in history as the savior of his country, so likewise is Confucius spoken of among his people as the wise philosopher, and patron of letters, and promoter of good government, but not as the founder of a religion, nor an object to be

worshiped. Educated Chinamen all profess to be disciples of him and to read his works, and to be guided by his instructions. In some respects they perhaps do, but they put their own interpretation upon the import of his teachings. There are no special teachers to expound his works, and every one is free to place such construction upon his teachings as his intelligence or impulses may lead to.

I am convinced that the power of the philosopher over his people has been overestimated by foreigners generally, and that the real nature and scope of his work have been largely misapprehended.

THE ORIGIN OF PAINTING.

By M. LAZAR POPOFF.

It is said repeatedly, as of course, that Egypt was the cradle of the arts. Yet archæologists like Lartet, Garrigue, Cristi, and others have shown that the first artistic manifestations go back to epochs far anterior to the ancient Egyptians. According to these authors, these first manifestations were contemporary with the presence of the reindeer in the south of France—when the mammoth had not yet quite disappeared, and when man, ignorant of the metals, made all his instruments of stone, bone, and wood. In fact, the first works of art, and particularly the first efforts at drawing, date from those prehistoric times. In France, the oldest remains of these works of art have been found, in the shape of drawings engraved with a flint point as ornaments on articles of reindeer-horn, in caves by the side of the fossil remains of animals which, like the mammoth, have since disappeared, or, like the reindeer, have abandoned those regions. Other drawings have been found on tablets of stone, horn, or mammoth-ivory.

It is not our intention to insist on the simply linear rudimentary designs of which these ornaments consist. We rather invite attention to more perfect and characteristic works, in which, according to the words of Carl Vogt, the spirit of observation and imitation of Nature, and especially of living Nature, is remarkably manifested. An image of a mammoth, found in the cave of La Magdelaine, in the Dordogne, is engraved on a tablet of mammoth-bone. Very striking are the ungainly attitude of the animal's massive body, its long hair, the form of its elevated skull, with concave forehead, and its enormous recurved tusks. All these traits, characteristic of this extinct type of pachyderm, are reproduced by the designer with a really artistic distinctness. The mammoth was already rare in Europe when this primitive artist lived; and this, perhaps, is the reason why only two of the numer-

ous designs found in the caves of France are of this animal.* The second of these drawings, found in La Lozère, represents a mammoth's head sculptured on a staff of command. The images of the chamois, bear, and ox are found more frequently; but figures of the reindeer are most numerous. Some are engraved on plates of bone, and others serve to ornament various objects. Sometimes groups of animals are represented, or, on the other hand, the animals are only partly drawn, and merely the head or head and chest are visible.

The larger part of these drawings do not excel in execution the figures which our school-boys make on walls; but the figures of the reindeer are generally superior on account of the remarkable care with which the characteristic lines of the animal are traced, and also, in examples that are otherwise very rare, by the addition of a few shadows. We conclude that the artist of the caves was particularly interested in the reindeer, which furnished his contemporaries with their principal food, as well as with clothing materials, arms for hunting, and household implements. We know, in fact, that the cave-dwellers lived on reindeer-meat, dressed themselves in its skin, made thread of its tendons, and cut their arrow-points from its bones. In other words, as the reindeer had not yet been domesticated, it stood to those primitive men as a valuable game, and the hunting of it occupied the larger part of their existence. We thus explain why that animal haunted the imagination of the artist of those times. The drawings of the chamois, the bear, and the ox were also often surprisingly exact and really valuable.

Besides these designs of mammals, there have been found in the caves of France a number of drawings of fishes, tolerably correct, but very uniform. According to Broca, they can all be referred to the salmon.

All these relics of the primitive arts of design prove abundantly that the men of that prehistoric age observed carefully the forms and attitudes of animals and were capable of representing them in an exact and elegant style, attesting, according to Broca, a real artistic sense.

Nothing like this has been observed in the reproduction of the human figure, and drawings of that kind are extremely rare. There are two such deserving mention, one of which represents a naked man, armed with a club and surrounded by animals; the second, a fishing scene, a man lancing a harpoon upon a marine animal—a fish according to Broca, a whale according to other authors. The whole of the design is puerile and out of shape, and

* Similar linear ornaments have been found in the caves in Belgium, and are referred by Dupont to the age of the mammoth.

the proportions are outrageously violated. This is not an exception, for the examination of all the drawings of this kind shows that skillful as were the men of those times in their drawings of animals, particularly of those which were important to them, they were bad delineators of the human figure. "I do not know," says Broca, "what prevented them from reaching perfection on this point, but the fact is indisputable and is certainly characteristic." Another no less characteristic point is the entire absence of designs representing plants. No design of a tree has been found, or of a bush or a flower, unless we regard as a flower the "three little rosettes" engraved on a handle of reindeer-horn, which some authors actually regard as a composite flower. This exclusive taste of the artists of the caves is evidently not accidental, for chance explains nothing; and we can not assume, with Carl Vogt, that primitive drawing originated in a general tendency of man toward imitation of living Nature. We believe that the object of these artistic productions was of a different character, and that they were intended, not for ornamentation of objects or for imitation pure and simple of Nature, but for the production of an instrument to be used in the struggle against Nature. We shall endeavor to substantiate this proposition in what follows, and shall have occasion to say something on the origin of painting in general.

We remark, first, that there is nothing to prove that the man of that time was intellectually superior to existing savages; and, if we observe these, we shall find that their drawings have usually a totally different significance from that which art has among civilized peoples; and that they have nothing in common with ornamentation and æsthetics in general. Indeed, numerous facts go to show that human thought, in the lower degrees of its development, distinguishes but poorly between subjective representations and objective reality, and that both give rise to the same ideas. For example, a savage seeing one of his family in a dream, can not imagine that the image is independent of the organic substance of the person in question; and he will see the same relation between the two as between a body and its image reflected by a surface of water. Thus the Basutos believe that if the shadow of a man is projected upon the water, the crocodiles will be able to seize the man himself. A like identification may be pushed to the point that tribes are known which use the same word for the soul, the image, and the shadow.

It is necessary to take this fact into consideration in order to appreciate the real sense of the primitive design, and to re-establish the conditions under which it originated. If we suppose a material relation between the image and the object as well as between the shadow and the object, it becomes evident that the

savage would comport himself similarly toward the image, the shadow, and the object. From his point of view the image and the object are in close relation, and an action upon one would operate in the same way upon the other. By this way of looking at things, as Sir John Lubbock says, the savage is convinced that an injury done to the image is inflicted upon the original; or, to use the words of Mr. Taylor, he thinks that by acting upon the copy he will reach the original. The evidences are many that demonstrate the importance attributed by savages to this mode of action on the original. Waitz relates, after Denghame, that in a tribe of western Africa it was dangerous to make a portrait of the natives, because they were afraid that by some kind of sorcery a part of their soul would pass into their image. Lubbock also speaks of the same fear as existing among savages; and the more like the portrait, the greater the danger to the original; for the more life there is in the copy, the less must be left in the person. One day, when some Indians were annoying Dr. Kane by their presence, he rid himself of them very quickly by telling them that he was going to make their portraits. Catlin tells a story, at once sober and comical, that when he was drawing the profile of a chief named Matochiga, the Indians around him seemed greatly moved, and asked him why he did not draw the other half of the chief's face. "Matochiga was never ashamed to look a white man square in the face." Matochiga had not till then seemed offended at the matter, but one of the Indians said to him sportively: "The Yankee knows that you are only half a man, and he has only drawn half of your face, because the other half is not worth anything." A bloody fight followed this explanation, and Matochiga was killed by a bullet which struck him in the side of the face that had not been drawn. A still more characteristic incident is communicated by M. Brouck concerning a Laplander who had come to visit him from motives of curiosity. He having drunk a glass of wine and seeming very much at ease, M. Brouck took his pencil and began drawing his portrait. All at once our subject's humor changed; he drew on his cap and started to run away. Explanations being had, the Laplander made the rash artist understand that, if he had let him copy his figure, the artist would have gained a dangerous influence over him.

Charlevoix said, in the last century, that the Illinois and Indians of some other tribes made little figures representing persons whose lives they wanted to shorten, and pierced them in the region of the heart. A custom still exists in Borneo that consists in making a figure in wax of the enemy whom one wishes to bewitch, and setting it before the fire to melt; it is assumed, according to Taylor, that the person aimed at is disorganized as fast as

his image disappears. The Peruvian sorcerers still proceed in the same way, except that their figures are made of rags. In the Indies, according to Dubois, they knead earth collected from a very salt place with hair or pieces of skin, and make a figure on the chest of which they write the name of an enemy, and then stab it with needles, or mutilate in some way, in the belief that the same harm will be suffered by the person represented.

Traces of this primitive superstition are also found among civilized people, for Grimm reports that in the eleventh century Jews were accused in Europe of having killed Bishop Ebergard by a sorcery of the kind. They were said to have made a figure of wax representing the bishop, hired a priest to baptize it, and put it into the fire. As soon as the wax was melted, the bishop was attacked by a mortal disease. The famous adventurer, Jacob, chief of the Pastorals, in the thirteenth century, seriously believed, as he says in his Demonology, that the devil taught men the art of making images of wax and clay, the destruction of which brought on the sickness and death of the persons they represented. It was a custom in the time of Catharine de' Medici to make such figures of wax, and melt them slowly before the fire or stab them with needles, in order to bring suffering to enemies. This operation was called putting a spell upon them. We may also mention the opinion of the earlier Christian writers, who believed, according to Draper, that painting and sculpture were interdicted in the Scriptures, and were consequently evil arts. It may be questioned if this opinion did not have its roots in the idea of primitive peoples that the art of drawing was an instrument of sorcery, by means of which one acquired the power to act upon a person. Mussulmans still have a horror of images, and the Koran forbids having one's portrait made and possessing any image at all.

We would not exhaust this evidence if we did not cite all the facts that go to prove that, in the mind of primitive man, it was sufficient to possess anything—a piece of the garment, hair, a bit of a nail—that had belonged to a person to have power to act upon him and do him harm. The belief in the efficacy of this means is still so strong among some backward peoples, that persons who have any reason to distrust others hide their clothes so that they shall not be robbed of any part of them. Others, when they cut their hair or nails, put the cut parts on the roofs of their houses or bury them in the ground. So peasants in some countries bury the teeth which they pull from themselves.

We should add, to complete the picture, that writing to the savage enjoys the same magic power as drawing. This is easily understood when we recollect that writing by figures preceded writing by letters or any conventional signs, and is still met

among some savage tribes. In these writings by figures, the fact that the man or animal represented is under the influence of an evil lot is indicated by an arrow directed from the mouth toward the heart. A sign of this kind is considered equivalent to a real possession of the animal or person represented.

We could hardly give more convincing proofs of the special significance attributed by the savage to drawing, regarded by him as an instrument of power over another; and while the examples which we have just brought together relate chiefly to man, we may assume logically that the same process—that is, a figured representation of animals—plays a like part in the struggle of the savage against his natural enemies. Other facts exist confirmatory of this hypothesis.

According to Mr. Tanner, the North American Indians, to assure success in their hunting expeditions, made rude drawings of the animal they were pursuing, and stabbed them in the region of the heart, under the conviction that they would thereby obtain power over the desired game. Taylor relates, according to an old observer among the Australians, that the natives, in one of their festival dances, construct a figure of the kangaroo with plants, in order that they may become masters of the real kangaroos of the forest. An Algonkin Indian, going out to kill an animal, hangs up a figure of it in his lodge; then, after giving it due warning, shoots an arrow at it. If the arrow hits, the animal will be killed. If a hunter, having touched a sorcerer's rod with his arrow, succeeded in hitting the track of the animal with the arrow, it would be stopped and held till the hunter could come up to it. The same object could be attained by drawing the figure of the animal on a piece of wood and addressing suitable prayers to the image.

Such was the function of drawing at its origin. An Indian song admirably explains this function, in the words "My drawing has made a god of me!" Faith could hardly be more vigorously expressed in the power of the art of drawing as an instrument by the aid of which primitive man obtained a supernatural power over his enemy or his game. Regarding the works of the cave men in the light of these facts, we perceive that the purpose that inspired them had few points in common with the sense of the beautiful or the tendency to imitation; and it is clear that if there existed in the mind of the primitive man a material relation between a being and its shadow or its image, that man thought that the same relation was preserved between the being and its image when transferred to any object whatever. The purpose to be reached was to possess the shadow of the coveted object, and the only means of accomplishing it was to fix upon something or another the silhouette of that shadow.

This, in our opinion, was the origin of drawing, and, consequently, of painting. It is worthy of remark that all works of this kind derived from the embryonic period of the arts of design betray the same lack of proportion and absence of symmetry characteristic of the silhouettes of shadows. The uniform impression given by the drawings is that they relate, not to the objects themselves, but to their shadows. It is further interesting to note that some contemporary savages, some Australians, for example, are still incapable of grasping the meaning of exact images, while they readily comprehend a crude, disproportioned drawing. Thus, to give them an idea of a man, you have to draw him with a very large head; a feature with which precisely corresponds a drawing representing a fisherman that has been found in a cave in France. He has a greatly reduced body, but his hand, armed with an enormous harpoon, is the hand of a giant.

In his struggle with surrounding Nature, a struggle of which he can not form an exact conception, primitive man had especial need to possess every means that could give him confidence in victory. In starting for the hunt he took with him, as the North American Indian does now, and as some players in our most civilized circles do under another form, the fetich that would insure success—that of an image of the animal to be killed. By engraving on the handle of his knife the image of a reindeer or some other animal, he did not think of ornamenting his weapon, but of exerting some magic power over his prey. And his belief in this mysterious power, by giving him boldness, energy, and sureness of movements, would often procure him success. Confidence does thus in all things. Just like the modern savage, the cave man would believe that the greater the resemblance between the image and the animal, the greater also would be the chance of acting upon the animal. Hence the care that was applied to the reproduction of the animals especially coveted and with which the contest would be hardest; and hence those perfect designs of the reindeer, that magnificent game of our ancestors.*

Very different are the characteristics of the drawings of human forms; and, to account for these differences, we should consider the fact that all the archæological data relative to the epoch of the reindeer testify that the disposition of the man of that age

* In this I differ from the students who find in some of these drawings evidence that the reindeer was a domesticated animal at that time. A representation of two reindeer has been found at Lozère, one of which wears what is regarded as a kind of halter. But the absence of fossil remains of dogs, without which domestication of the reindeer is impossible, pleads, as Carl Vogt remarks, against the existence of the domesticated reindeer. In my opinion, this supposed halter represents rather the emblematic line of which I have spoken, proceeding from the mouth to the heart, indicating the enchantment thrown at the animal by the hunter.

was pacific. Broca calls these men "peaceful hunters," and attributes a gentle character to them. He remarks that an examination of their arsenal very rarely brings out warlike arms, and that we can thus satisfy ourselves of their peaceful character. The Belgian archæologist, M. Dupont, observes that the cave-dwellers of his country had no idea of war. And, if we have a right to compare the existing savage with primitive man, we find that the Eskimo, who is nearest like him, is quiet and peaceful. The Eskimo whom Ross met on the shores of Baffin's Bay could not be made to understand what war is, and possessed no warlike weapons. While, then, we may believe that the cave men rarely raised their hands against one another, it nevertheless remains determined that they waged a bitter and relentless war against animals. Hence they rarely had occasion to exercise themselves in drawing the human form; and hence the imperfect character of their human images as compared with those of animals. As to the forms of plants, it may be remarked that the boreal flora of that epoch, not being at all threatening, could furnish little food for superstition; and no drawings of plants are found in the caves.

In short, the condition of the art of drawing with primitive man seems to be in complete harmony with the meaning which we have attributed to drawing itself, of its being inspired by belief in the existence of a material relation between a being and its image and in the possibility of acting on the first through the second. Consequently, the principle of painting can not be found in a natural tendency of primitive man to the artificial imitation of living Nature, but seems rather to be derived from the desire of subjecting that Nature to its needs, and of subjugating it. In the course of its progressive improvements, the art of drawing has gradually lost its primitive significance and original meaning, till it has become what it is now. It does not differ much, however, from what it was originally; for, while the primitive man expected to reach the living being in its image, it is still life which the civilized man seeks to-day in works of art.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

Dr. Peters, the African traveler, believes that the Waganda, or people of Uganda, are descended from the ancient Egyptians; and some color is apparently lent to his view by the burial of their kings in mounds, the custom of embalming, and the existence of ancient rock excavations. But the Waganda might have borrowed these things from their northern neighbors. Dr. Peters observes that they undoubtedly excel every other African nation in the development of their intelligence, and that, in contrast to all other negro tribes, they feel the need of progress. It is believed that in the oldest of the burial mounds are interred records of the dead sovereigns that will explain the origin of the race; but at present the Waganda will not allow a search to be made.

HIGH LIFE.

EVERYBODY knows mountain flowers are beautiful. As one rises up any minor height in the Alps or the Pyrenees, below snow-level, one notices at once the extraordinary brilliancy and richness of the blossoms one meets there. All Nature is dressed in its brightest robes. Great belts of blue gentian hang like a zone on the mountain slopes; masses of yellow globe-flower star the upland pastures, nodding heads of soldanella lurk low among the rugged bowlders by the glacier's side. No lowland blossoms have such vividness of coloring, or grow in such conspicuous patches. To strike the eye from afar, to attract and allure at a distance, is the great aim and end in life of the Alpine flora.

Now, why are Alpine plants so anxious to be seen of men and angels? Why do they flaunt their golden glories so openly before the world, instead of shrinking in modest reserve beneath their own green leaves, like the Puritan primrose and the retiring violet? The answer is, Because of the extreme rarity of the mountain air. It's the barometer that does it. At first sight, I will readily admit, this explanation seems as fanciful as the traditional connection between Goodwin Sands and Tenterden Steeple. But, like the amateur stories in country papers, it is "founded on fact," for all that. (Imagine, by the way, a tale founded entirely on fiction! How charmingly aërial!) By a roundabout road, through varying chains of cause and effect, the rarity of the air does really account in the long run for the beauty and conspicuousness of the mountain flowers.

For bees, the common go-betweens of the loves of the plants, cease to range about a thousand or fifteen hundred feet below snow-level. And why? Because it's too cold for them? Oh, dear, no; on sunny days in early English spring, when the thermometer does'nt rise above freezing in the shade, you will see both the honey-bees and the great black bumble as busy as their conventional character demands of them among the golden cups of the first timid crocuses. Give the bee sunshine, indeed, with a temperature just about freezing-point, and he'll flit about joyously on his communistic errand. But bees, one must remember, have heavy bodies and relatively small wings: in the rarefied air of mountain heights they can't manage to support themselves in the most literal sense. Hence their place in these high stations of the world is taken by the gay and airy butterflies, which have lighter bodies and a much bigger expanse of wing-area to buoy them up. In the valleys and plains the bee competes at an advantage with the butterflies for all the sweets of life, but in this broad subglacial

belt on the mountain-sides, the butterflies in turn have things all their own way. They flit about like monarchs of all they survey, without a rival in the world to dispute their supremacy.

And how does the preponderance of butterflies in the upper regions of the air affect the color and brilliancy of the flowers? Simply thus: Bees, as we are all aware on the authority of the great Dr. Watts, are industrious creatures which employ each shining hour (well-chosen epithet, "shining") for the good of the community, and to the best purpose. The bee, in fact, is the *bon bourgeois* of the insect world: he attends strictly to business, loses no time in wild or reckless excursions, and flies by the straightest path from flower to flower of the same species with mathematical precision. Moreover, he is careful, cautious, observant, and steady-going—a model business man, in fact, of sound middle-class morals and sober middle-class intelligence. No flitting for him, no coquetting, no fickleness. Therefore, the flowers that have adapted themselves to his needs, and that depend upon him mainly or solely for fertilization, waste no unnecessary material on those big, flaunting colored posters which we human observers know as petals. They have, for the most part, simple blue or purple flowers, tubular in shape and, individually, inconspicuous in hue; and they are oftenest arranged in long spikes of blossom to avoid wasting the time of their winged Mr. Bultitudes. So long as they are just bright enough to catch the bee's eye a few yards away, they are certain to receive a visit in due season from that industrious and persistent commercial traveler. Having a circle of good customers upon whom they can depend with certainty for fertilization, they have no need to waste any large proportion of their substance upon expensive advertisements or gaudy petals.

It is just the opposite with butterflies. Those gay and irrepressible creatures, the fashionable and frivolous element in the insect world, gad about from flower to flower over great distances at once, and think much more of sunning themselves and of attracting their fellows than of attention to business. And the reason is obvious, if one considers for a moment the difference in the political and domestic economy of the two opposed groups. For the honey-bees are neuters, sexless purveyors of the hive, with no interest on earth save the storing of honey for the common benefit of the phalanstery to which they belong. But the butterflies are full-fledged males and females, on the hunt through the world for suitable partners: they think far less of feeding than of displaying their charms; a little honey to support them during their flight is all they need: "For the bee, a long round of ceaseless toil; for me," says the gay butterfly, "a short life and a merry one." Mr. Harold Skimpole needed only "music, sun-

shine, a few grapes." The butterflies are of his kind. The high mountain zone is for them a true ball-room; the flowers are light refreshments laid out in the vestibule. Their real business in life is not to gorge and lay by, but to coquette and display themselves and find fitting partners.

So while the bees with their honey-bags, like the financier with his money-bags, are storing up profit for the composite community, the butterfly, on the contrary, lays himself out for an agreeable flutter, and sips nectar where he will, over large areas of country. He flies rather high, flaunting his wings in the sun, because he wants to show himself off in all his airy beauty; and when he spies a bed of bright flowers afar off on the sun-smitten slopes, he sails off toward them lazily, like a grand signior who amuses himself. No regular plodding through a monotonous spike of plain little bells for him; what he wants is brilliant color, bold advertisement, good honey, and plenty of it. He doesn't care to search. Who wants his favors must make himself conspicuous.

Now, plants are good shopkeepers; they lay themselves out strictly to attract their customers. Hence the character of the flowers on this beeless belt of mountain-side is entirely determined by the character of the butterfly fertilizers. Only those plants which laid themselves out from time immemorial to suit the butterflies, in other words, have succeeded in the long run in the struggle for existence. So the butterfly-plants of the butterfly-zone are all strictly adapted to butterfly tastes and butterfly fancies. They are, for the most part, individually large and brilliantly colored; they have lots of honey, often stored at the base of a deep and open bell which the long proboscis of the insect can easily penetrate; and they habitually grow close together in broad belts or patches, so that the color of each re-enforces and aids the color of the others. It is this cumulative habit that accounts for the marked flower-bed or jam-tart character which everybody must have noticed in the high Alpine flora.

Aristocracies usually pride themselves on their antiquity; and the high life of the mountains is undeniably ancient. The plants and animals of the butterfly-zone belong to a special group which appears everywhere in Europe and America about the limit of snow, whether northward or upward. For example, I was pleased to note near the summit of Mount Washington (the highest peak in New Hampshire) that a large number of the flowers belonged to species well known on the open plains of Lapland and Finland. The plants of the High Alps are found also, as a rule, not only on the High Pyrenees, the Carpathians, the Scotch Grampians, and the Norwegian fjelds, but also round the Arctic Circle in Europe and America. They reappear at long distances where suitable

conditions recur; they follow the snow-line as the snow-line recedes ever in summer higher north toward the pole or higher vertically toward the mountain summits. And this bespeaks in one way to the reasoning mind a very ancient ancestry. It shows they date back to a very old and cold epoch.

Let me give a single instance which strikingly illustrates the general principle. Near the top of Mount Washington, as aforesaid, lives to this day a little colony of very cold-loving and mountainous butterflies, which never descend below a couple of thousand feet from the wind-swept summit. Except just there, there are no more of their sort anywhere about; and as far as the butterflies themselves are aware, no others of their species exist on earth; they never have seen a single one of their kind, save of their own little colony. One might compare them with the Pitcairn Islanders in the South Seas—an isolated group of English origin, cut off by a vast distance from all their congeners in Europe or America. But if you go north some eight or nine hundred miles from New Hampshire to Labrador, at a certain point the same butterfly reappears, and spreads northward toward the pole in great abundance. Now, how did this little colony of chilly insects get separated from the main body and islanded, as it were, on a remote mountain-top in far warmer New Hampshire?

The answer is, they were stranded there at the end of the Glacial epoch.

A couple of hundred thousand years ago, or thereabouts—don't let us haggle, I beg of you, over a few casual centuries—the whole of northern Europe and America was covered from end to end, as everybody knows, by a sheet of solid ice, like the one which Frithiof Nansen crossed from sea to sea on his own account in Greenland. For many thousand years, with occasional warmer spells, that vast ice-sheet brooded, silent and grim, over the face of the two continents. Life was extinct as far south as the latitude of New York and London. No plant or animal survived the general freezing. Not a creature broke the monotony of that endless glacial desert. At last, as the celestial cycle came round in due season, fresh conditions supervened. Warmer weather set in, and the ice began to melt. Then the plants and animals of the subglacial district were pushed slowly northward by the warmth after the retreating ice-cap. As time went on, the climate of the plains got too hot to hold them. The summer was too much for the glacial types to endure. They remained only on the highest mountain-peaks or close to the southern limit of eternal snow. In this way, every isolated range in either continent has its own little colony of arctic or glacial plants and animals, which still survive by themselves, unaffected by inter-

course with their unknown and unsuspected fellow-creatures elsewhere.

Not only has the Glacial epoch left these organic traces of its existence, however; in some parts of New Hampshire where the glaciers were unusually thick and deep, fragments of the primeval ice itself still remain on the spots where they were originally stranded. Among the shady glens of the White Mountains there occur here and there great masses of ancient ice, the unmelted remnant of primeval glaciers; and one of these is so large that an artificial cave has been cleverly excavated in it, as an attraction for tourists, by the canny Yankee proprietor. Elsewhere the old ice-blocks are buried under the *débris* of moraine-stuff and alluvium, and are only accidentally discovered by the sinking of what are locally known as ice-wells. No existing conditions can account for the formation of such solid rocks of ice at such a depth in the soil. They are essentially glacier-like in origin and character; they result from the pressure of snow into a crystalline mass in a mountain valley; and they must have remained there unmelted ever since the close of the Glacial epoch, which, by Dr. Croll's calculations, must most probably have ceased to plague our earth some eighty thousand years ago. Modern America, however, has no respect for antiquity; and it is at present engaged in using up this palæocrystic deposit—this belated storehouse of prehistoric ice—in the manufacture of gin slings and brandy cocktails.

As one scales a mountain of moderate height—say seven or eight thousand feet—in a temperate climate, one is sure to be struck by the gradual diminution as one goes in the size of the trees, till at last they tail off into mere shrubs and bushes. This diminution—an old commonplace of tourists—is a marked characteristic of mountain plants, and it depends, of course, in the main upon the effect of cold, and of the wind in winter. Cold, however, is by far the more potent factor of the two, though it is the least often insisted upon; and this can be seen in a moment by any one who remembers that trees shade off in just the self-same manner near the southern limit of permanent snow in the arctic regions. And the way the cold acts is simply this: it nips off the young buds in spring in exposed situations, as the chilly sea-breeze does with coast plants, which, as we commonly but incorrectly say, are "blown sideways" from seaward.

Of course, the lower down one gets, and the nearer to the soil, the warmer the layer of air becomes, both because there is greater radiation and because one can secure a little more shelter. So, very far north, and very near the snow-line on mountains, you always find the vegetation runs low and stunted. It takes advantage of every crack, every cranny in the rocks, every sunny little

nook, every jutting point or wee promontory of shelter. And as the mountain plants have been accustomed for ages to the strenuous conditions of such cold and wind-swept situations, they have ended, of course, by adapting themselves to that station in life to which it has pleased the powers that be to call them. They grow quite naturally low and stumpy and rosette-shaped; they are compact of form and very hard of fiber; they present no surface of resistance to the wind in any way; rounded and boss-like, they seldom rise above the level of the rocks and stones whose interstices they occupy. It is this combination of characters that makes mountain plants such favorites with florists; for they possess of themselves that close-grown habit and that rich profusion of clustered flowers which it is the grand object of the gardener by artificial selection to produce and encourage.

When one talks of "the limit of trees" on a mountain-side, however, it must be remembered that the phrase is used in a strictly human or Pickwickian sense, and that it is only the size, not the type, of the vegetation that is really in question. For trees exist even on the highest hill-tops; only they have accommodated themselves to the exigencies of the situation. Smaller and ever smaller species have been developed by natural selection to suit the peculiarities of these inclement spots. Take, for example, the willow and poplar group. Nobody would deny that a weeping willow by an English river, or a Lombardy poplar in an Italian avenue, was as much of a true tree as an oak or a chestnut. But as one mounts toward the bare and wind-swept mountain heights one finds that the willows begin to grow downward gradually. The "netted willow" of the Alps and Pyrenees, which shelters itself under the lee of little jutting rocks, attains a height of only a few inches; while the "herbaceous willow," common on all very high mountains in western Europe, is a tiny, creeping weed, which nobody would ever take for a forest tree by origin at all, unless he happened to see it in the catkin-bearing stage, when its true nature and history would become at once apparent to him.

Yet this little herb-like willow, one of the most northerly and hardy of European plants, is a true tree at heart none the less for all that. Soft and succulent as it looks in branch and leaf, you may yet count on it sometimes as many rings of annual growth as on a lordly Scotch fir tree. But where? Why, underground. For see how cunning it is, this little stunted descendant of proud forest lords: hard-pressed by Nature, it has learned to make the best of its difficult and precarious position. It has a woody trunk at core, like all other trees; but this trunk never appears above the level of the soil: it creeps and roots underground in tortuous zigzags between the crags and bowlders that lie strewn through

its thin sheet of upland leaf-mold. By this simple plan the willow manages to get protection in winter, on the same principle as when we human gardeners lay down the stems of vines; only the willow remains laid down all the year and always. But in summer it sends up its short-lived herbaceous branches, covered with tiny green leaves, and ending at last in a single silky catkin. Yet between the great weeping willow and this last degraded mountain representative of the same primitive type, you can trace in Europe alone at least a dozen distinct intermediate forms, all well marked in their differences, and all progressively dwarfed by long stress of unfavorable conditions.

From the combination of such unfavorable conditions in arctic countries and under the snow-line of mountains there results a curious fact, already hinted at above, that the coldest floras are also, from the purely human point of view, the most beautiful. Not, of course, the most luxuriant: for lush richness of foliage and "breadth of tropic shade" (to quote a noble lord) one must go, as every one knows, to the equatorial regions. But, contrary to the common opinion, the tropics, hoary shams, are not remarkable for the abundance or beauty of their flowers. Quite otherwise, indeed: an unrelieved green strikes the key-note of equatorial forests. This is my own experience, and it is borne out (which is far more important) by Mr. Alfred Russel Wallace, who has seen a wider range of the untouched tropics, in all four hemispheres—northern, southern, eastern, western—than any other man, I suppose, that ever lived on this planet. And Mr. Wallace is firm in his conviction that the tropics in this respect are a complete fraud. Bright flowers are there quite conspicuously absent. It is rather in the cold and less favored regions of the world that one must look for fine floral displays and bright masses of color. Close up to the snow-line the wealth of flowers is always the greatest.

In order to understand this apparent paradox one must remember that the highest type of flowers, from the point of view of organization, is not at the same time by any means the most beautiful. On the contrary, plants with very little special adaptation to any particular insect, like the water-lilies and the poppies, are obliged to flaunt forth in very brilliant hues and to run to very large sizes in order to attract the attention of a great number of visitors, one or other of whom may casually fertilize them; while plants with very special adaptations, like the sage and mint group, or the little English orchids, are so cunningly arranged that they can not fail of fertilization at the very first visit, which of course enables them to a great extent to dispense with the aid of big or brilliant petals. So that, where the struggle for life is fiercest and adaptation most perfect, the flora will on the whole

be not most, but least, conspicuous in the matter of very handsome flowers.

Now, the struggle for life is fiercest, and the wealth of Nature is greatest, one need hardly say, in tropical climates. There alone do we find every inch of soil "encumbered by its waste fertility," as Comus puts it; weighed down by luxuriant growth of tree, shrub, herb, creeper. There alone do lizards lurk in every hole; beetles dwell manifold in every cranny; butterflies flock thick in every grove; bees, ants, and flies swarm by myriads on every sun-smitten hillside. Accordingly, in the tropics, adaptation reaches its highest point; and tangled richness, not beauty of color, becomes the dominant note of the equatorial forests. Now and then, to be sure, as you wander through Brazilian or Malayan woods, you may light upon some bright tree clad in scarlet bloom, or some glorious orchid drooping pendent from a bough with long sprays of beauty; but such sights are infrequent. Green, and green, and ever green again—that is the general feeling of the equatorial forest; as different as possible from the rich mosaic of a high alp in early June, or a Scotch hillside deep in golden gorse and purple heather in broad August sunshine.

In very cold countries, on the other hand, though the conditions are severe, the struggle for existence is not really so hard, because, in one word, there are fewer competitors. The field is less occupied; life is less rich, less varied, less self-strangling. And, therefore, specialization has not gone nearly so far in cold latitudes or altitudes. Lower and simpler types everywhere occupy the soil; mosses, matted flowers, small beetles, dwarf butterflies. Nature is less luxuriant, yet in some ways more beautiful. As we rise on the mountains the forest trees disappear, and with them the forest beasts, from bears to squirrels; a low, wind-swept vegetation succeeds, very poor in species, and stunted in growth, but making a floor of rich flowers almost unknown elsewhere. The humble butterflies and beetles of the chillier elevation produce in the result more beautiful bloom than the highly developed honey-seekers of the richer and warmer lowlands. Luxuriance is atoned for by a Turkey carpet of floral magnificence.

How, then, has the world at large fallen into the pardonable error of believing tropical nature to be so rich in coloring, and circumpolar nature to be so dingy and unlovable? Simply thus, I believe. The tropics embrace the largest land areas in the world, and are richer by a thousand times in species of plants and animals than all the rest of the earth in a lump put together. That richness necessarily results from the fierceness of the competition. Now, among this enormous mass of tropical plants it naturally happens that some have finer flowers than any temperate species; while as to the animals and birds, they are undoubtedly, on the

whole, both larger and handsomer than the fauna of colder climates. But in the general aspect of tropical nature an occasional bright flower or brilliant parrot counts for very little among the mass of lush green which surrounds and conceals it. On the other hand, in our museums and conservatories we sedulously pick out the rarest and most beautiful of these rare and beautiful species, and we isolate them completely from their natural surroundings. The consequence is that the untraveled mind regards the tropics mentally as a sort of perpetual replica of the hot-houses at Kew, superimposed on the best of Mr. Bull's orchid shows. As a matter of fact, people who know the hot world well can tell you that the average tropical woodland is much more like the dark shade of Box Hill or the deepest glades of the Black Forest. For really fine floral display in the mass, all at once, you must go, not to Ceylon, Sumatra, Jamaica, but to the far north of Canada, the Bernese Oberland, the moors of Inverness-shire, the North Cape of Norway. Flowers are loveliest where the climate is coldest; forests are greenest, most luxuriant, least blossoming, where the conditions of life are richest, warmest, fiercest. In one word, High Life is always poor but beautiful.—*Cornhill Magazine.*

SKETCH OF JAMES CURTIS BOOTH.

THE life of Prof. Booth is divided by Mr. Patterson Dubois, in his memorial address, into three periods: that of his preparatory student life, or the formative period, which closed in 1835–'36; the creative period, so named "because it called into being a method of technical education which has, probably more than anything else, resulted in establishing chemistry as a factor in commerce, and in gaining for the chemist a recognized place in the economy of the world's work," 1836 to 1849; and the period of his official life as melter and refiner at the United States Mint in Philadelphia.

James Curtis Booth was born in Philadelphia, July 28, 1810, the son of George Booth, of New Castle, Del., and Ann Balton, of Chestertown, Md.; and died in Philadelphia, March 21, 1888. He was taught in Philadelphia, at the seminary in Hartsville, Pa., and at the University of Pennsylvania, whence he was graduated in 1829. He then spent a year at the Rensselaer Polytechnic Institute at Troy, N. Y. He had a decided preference for the study of chemistry, of which he very early realized the capabilities and the practical value. Seeking opportunities and facilities for the performance of laboratory work in connection with his studies which America could not afford, he went to Europe

for them, and was the first American student who visited Germany for that purpose. He spent the year 1833 in Wöhler's private laboratory in Cassel; then practiced for nine months in the laboratory of Prof. Gustav Magnus, in Berlin; and employed the rest of three years abroad in attending lectures in Berlin and Vienna, and in visiting manufacturing establishments on the Continent and in England.

Having returned home, Mr. Booth established, in 1836, a student's laboratory—"the parent of all our existing laboratories for students in applied chemistry"—and became a teacher. "But it was no part of Mr. Booth's idea," Mr. Dubois says, "to make the laboratory course usurp the rightful position of the text-book and the lecture. He saw the great want of a supplementer rather than a supplanter. How truly he discerned what the scientific as well as the commercial world required, and how fully he met that requirement, needs no explanation here. The student's laboratories all over the country—if not beyond—as well as the throng of students who have come into and gone from his own laboratory during the past half-century—all attest the foresight, the judgment, the energy of a scientist and a business man."

In 1836 Mr. Booth was appointed Professor of Chemistry applied to the Fine Arts, in the Franklin Institute. In this capacity he delivered, between 1836 and 1845, three courses of lectures, of three seasons to each course. From 1842 to 1845 he was also Professor of Chemistry in the Central High School of Philadelphia. He interested himself in mineralogy and geology, and engaged in the Geological Surveys of Pennsylvania and Delaware, concerning which Prof. J. P. Lesley has written: "Prof. Booth and John Frazer, then a young man, were appointed by Prof. Rogers, in the spring of 1836, his two assistants in prosecuting the work of the first Geological Survey of Pennsylvania. From spring to fall they traveled along the Susquehanna and Juniata Valleys, blocking out the order of the great formations. Prof. Booth was sent by Prof. Rogers up the Potomac to make a section which could be compared with the Juniata section; and, when these three met at Huntingdon, he announced, to the astonishment of Mr. Rogers, that the mountains which fill the middle belt of Pennsylvania were made by two separate formations, now known as No. IV and No. X. Mr. Rogers was unwilling to accept this conclusion, and instructed Mr. Frazer to go to the Huntingdon Bedford line and make a cross-section from the Broad-Top coal down to the limestone of Morrison's Cove. At the end of the week the three met again in Huntingdon, and Mr. Frazer confirmed the statement of Prof. Booth. Mr. Rogers was still dissatisfied, and then went himself to repeat the section made by Mr. Frazer, finding it correct, and then accepting Prof. Booth's

Potomac section. Thus the grand column of our Palæozoic formations was established, and the credit of it is due to Prof. Booth. . . . Both Prof. Rogers's assistants resigned at the end of the year; and Mr. Booth was then appointed immediately, or not long thereafter, State Geologist of Delaware. His work in Delaware was published in his report, an octavo volume, now so rare that it is impossible to obtain a copy. My belief is that Prof. Booth abandoned field work very early in his career, and devoted himself to his chemical laboratory. At all events he is known in science altogether as an accomplished chemist, with a great reputation for diligence and accuracy, especially in the field of mineral analysis." The Delaware survey was under Prof. Booth's charge in the years 1837–'38; and a summary of the results to which it led was published in the Annual Report of the Survey in 1839, and in a memoir on the subject in 1841.

The act providing for the geological survey of Delaware required that an equal portion of the appropriation should be expended in each county. But the several counties did not all need the same attention. The geologist, however, was expected to spend an equal portion of his time in each county. He improved the time, when the geological work did not demand the whole of it, by traversing different parts of the counties, and imparting to the people such knowledge relative to agriculture as lay within the sphere of his information; and he embodied agricultural essays in his report. Pertinently to this instance of a characteristic weakness of law-makers, Prof. Booth remarked in his report on the unwisdom of allowing local interests to sway so much in legislation, when more could be gained in the long run by taking broader views. Believing that the wealth of the people could be promoted by their employing their own resources, however limited, he directed much time to the development of such as deposits of shells and decomposed organic matter, glass-making materials, potter's clay, iron, and copperas.

In explanation of the admission of theoretical matter into the report, when the work was designed to possess a practical character, he said: "In all probability the number of those who may peruse these pages is large, and their attainments are of a varied nature; some being purely practical men, others again having made considerable attainments in literature and science; and hence it was deemed advisable to adapt the memoir to the various demands of the community. . . . I am well aware of an opinion, too generally prevalent among men devoted to practical pursuits, that an attention to theories is rather prejudicial than otherwise to the successful pursuit of business. Whatever grounds they may have for such views, they are not valid when applied in a general way to theoretic investigations; for, independently of

other proofs of the incorrectness of their conclusions, it may be shown that many valuable practical results have either originated with or were improved by theorists, by those who have experimented with a view to establishing, maintaining, or refuting. Now, in regard to agriculture, it may be observed that it had already made considerable advancement when it began to assume a scientific form; but from that period to the present, by deriving assistance from other sciences, and particularly from chemistry, its progress toward perfection has been constant and rapid."

Prof. Booth's attention was drawn to the subject of refining cobalt, concerning which little or nothing was known outside of the commercial refineries, by the ill-success of an experiment in mining the metal which was begun in 1845. It was at the Mine La Mott, in Missouri, where he mined a large amount of cobalt, which was sent to England. It was returned as impure; whereupon Prof. Booth at once set to work to discover the best method of refining the metal—and succeeded.

Of Prof. Booth's qualities as an instructor Dr. Alexander Mucklé, a pupil of his, as also of Wöhler and Bunsen, and afterward his assistant at the Mint, is quoted as saying: "With this experience of teachers and means of comparison, I can say that Mr. Booth had few if any superiors as a teacher of practical chemistry; that he kept abreast of the times by constantly securing the best and latest scientific books and periodicals. A high value was placed upon a course in his laboratory, which soon became widely known and in great repute as a place for learning chemistry; and his teachings are believed to have had a potent influence in developing and disseminating the knowledge of the science and its practical applications."

Prof. Booth was appointed Melter and Refiner of the Mint by President Taylor in 1849, and entered that service on December 10th of that year. The time corresponded closely with the discovery of gold in California. The influx of gold from that source, already heavy, increased rapidly, and added greatly to the work of his office, while the quality of the metal increased considerably the difficulty of dealing with it. The new gold was alloyed with silver in excess of the amount admissible in the coinage, and this had to be extracted. The provisions of the Mint, which had been adapted for the treatment of the bullion which had been previously sent there, were not suitable to the refinement of this gold. New methods had to be adopted, and the whole plan of the parting apparatus had to be reconstructed. It was Prof. Booth's duty to make this adjustment. The process already known in the laboratories had to be expanded and used on a manufacturing scale. "To this work, as well as to all the other labors of his department," says Mr. Robert Patterson, Mr. Booth "brought the full knowledge of

theory and practice derived from former professional experience, and further showed, what is not always the case with chemists, a capacity to apply his knowledge in the larger way required for commercial results." There was delay at first in disposing of the gold that came to the Mint, and some impatience on the part of consignors, but the capacity of the Mint was soon enlarged to meet promptly every demand. In the course of five years the pressure of gold at the Philadelphia office was relieved by the creation of a Government Assay Office in New York and a Branch Mint at San Francisco. Then came a change in the standard of silver coin, causing an immense recoinage in small pieces; and then the issue, in place of the old copper cents, of copper-nickel pieces, and, after these, of bronze; each calling for other processes of assay and involving additional work.

An improved process for refining gold was described by Prof. Booth, in a letter to the Wastage Commission, as follows: "I refine usually to 993 and 995 m., and sometimes, to make a finer gold, I heat the alloy of gold and silver with parting acid, so as to nearly separate them, and then heat the residue with oil of vitriol and saltpeter, at a steam-heat, by which I have brought the gold to 998 m. The process is my own, and not known outside of the Mint." A paragraph from an article in the Journal of the American Chemical Society for June, 1885, on The Smelting Furnace of the United States Mint, is quoted by Mr. Dubois as characteristic. "My last improvement," Prof. Booth says, "which is still practiced, consists in the very simple operation of melting all the iron residues from the furnaces, even including grate-bars, and keeping them in a quiet melted state, so as to allow the heavier gold and silver to settle out of the iron. When the mass is cold, the precious metal is knocked off the bottom by a hammer as a single tough king, with scarcely a trace of iron in it, while the iron mass above it has never yielded a trace of gold or silver to the assayer. Instead of spending three weeks of annual vacation from melting in hammering tons of accumulated iron, we now melt through the year, whenever convenient, from five to fifty pounds of iron residues at a time. We gathered in one melting, last autumn, a cake of a few ounces of gold and silver from a mass of over fifty pounds of iron in a part of a day, and the latter was entirely free from the precious metals. When I first succeeded with this process, I could hardly believe in the perfect separation from iron, and the late Mr. J. R. Eckfeldt, the best assayer in the United States, doubted it, until, by numerous tests made from a piece of some thirty pounds of iron, he found a total absence of gold and silver."

The difficulties met at the Mint in adapting processes to the various kinds of metallic impurity that came in with the gold

and silver, and the responsibility of managing so large amounts, for which he was accountable in law to the full value, weighed heavily and constantly on his mind, and told severely upon his physical constitution, and, according to Mr Dubois, in his later years a painful anxiety "seemed to be ineradicably seared into his very life." His noticeable failure is traced by Mr. Dubois from the great "wastages" of 1872, together with subsequent difficulties in the recoinage of seventeen millions of our gold coin in 1873. Prof. Booth himself wrote upon this subject in a private letter in October, 1887: "The whole truth is that the constantly increasing business of the Mint beyond its own capacity for bullion storage has been increasingly weighing down my anxious thoughts for its safety, and you may add to that the consciousness that I was personally responsible for every ounce of bullion received, and then you will readily perceive sufficient ground for a constant anxious care, which I sometimes imagined to be as the square or cube of the extra quantity of bullion constantly poured in. . . . It was that constant and constantly augmenting ounce-for-ounce responsibility that finally affected my mind, and I rather think broke me down. I went home quite sick from the Mint early in April, and lay on my back for about three months. I suppose that such a statement will be quite sufficient to explain my present position. I am glad to say that I had sufficient strength to resign from my place in the Mint" (he resigned in August, 1887, after thirty-nine years of service), "although no one is yet appointed to take my place. However, I do not go more than once a week to the Mint, and shall be glad when the string of union is severed. . . . From my age, over seventy-seven, I hardly expect restoration of full strength, and am satisfied with what Providence designs." His successor was not appointed when he died.

Prof. Booth had a variety of side-pursuits, and was especially fond of linguistic studies, among which he took a particular interest in phonetics, short-hand writing, and the reform of English orthography. He regarded phonography as important in elementary education, and thought it should be required as an essential branch. Having mastered Pitman's Phonography, he perceived the defective character of the text-books on the subject, and himself published an elementary work upon it in 1849—the Phonographic Instructor. The Instructor was republished, with a key, in 1850 and in 1856. The book was a successful one.

Most of Prof. Booth's writings bore upon the special field of his studies and his work. Having become a member of the American Philosophical Society in 1839, he, in connection with Prof. Martin H. Boyé, communicated to the eighth volume of its transactions, new series, a paper on the Conversion of Benzoic Acid into Hippuric Acid. A considerable number of the reports of

the Franklin Institute Committee on Science and the Arts were of his writing. In co-operation with Campbell Morfit he prepared a report on Recent Improvements in the Chemical Arts, which was published by the Smithsonian Institution in 1852. The conservative, practical spirit that presided over the composition of this work is illustrated in the preface, where the authors say: "We have freely exercised discrimination in the selection of subjects, and have omitted much that we found in applied chemistry, because novel views need, in many cases, further confirmation to render them reliable in practice, and, if presented too early to the artisan, may be productive of more evil than good. We have kept in view the benefit of the practical man, the manufacturer or worker, and, while we have not avoided scientific terms where they were more convenient, we have generally used words of description intelligible to every one. We have confined ourselves to such foreign improvements in the chemical arts, whether patented or not, as we believed the American artisan might avail himself of, frequently offering critical remarks on them, and sometimes pointing out where improvements were likely to be made."

In the Journal of the American Chemical Society are papers on some methods of toughening gold and silver (September, 1884): A General Method of toughening Gold and Silver in the Melting Crucible (June, 1884); and The Smelting Furnace of the U. S. Mint (June, 1885), from which we have quoted. Other papers, the media of publication of which are not given by Mr. Dubois, are: On Beet-root Sugars (1842); Chrome Iron Analysis (1842); Constitution of Glycerin and Oily Acids (1848); and a Report on the Water-supply of Philadelphia (1862). His most conspicuous effort in literature was the Encyclopædia of Chemistry published in Philadelphia in 1850, which was written chiefly by him, but on the last half of which Dr. Campbell Morfit assisted.

Prof. Booth received the degree of LL. D. from the University of Lewisburg in 1867, and that of Ph. D. from the Rensselaer Polytechnic Institute in 1884. He was made a member of the Pennsylvania Horticultural Society in 1842; of the Philadelphia Academy of Natural Sciences in 1852; of the Maryland Institute for the Promotion of the Mechanic Arts in 1853; of the Philadelphia Society for Promoting Agriculture about 1859; and of the Historical Society of Pennsylvania in 1884. He was President of the American Chemical Society in 1883 and 1884, and declined reelection for a third term; and was interested in the diocesan work of the Protestant Episcopal Church and in various philanthropies. He is described as having been personally a gentleman of refined manners, pleasing address, and a cheerful disposition, which was often obscured, however, by his nervous intensity.

EDITOR'S TABLE.

UNIVERSITY EXTENSION.

THE article by Prof. C. Hanford Henderson on University Extension, which appears in the present number of the Monthly, is one which deserves and doubtless will receive a wide and sympathetic attention. Prof. Henderson states his case well, and no intelligent reader can fail to be impressed with the importance of the movement which he describes and advocates. For our own part we think its importance can hardly be over-estimated. It aims at nothing less than an intellectual revolution—at placing within the reach of thousands in every part of the country educational advantages which hitherto have been confined to university students. Useful as the colleges and universities are in their way, we incline to the opinion that what is known as university extension holds out a promise of yet greater usefulness. The former are often spoken of as "seats" of learning, and the expression is appropriate; but, in the extension movement, learning leaves its seats and goes forth to find its disciples in the highways and byways. This simple fact is a pledge of a more living adaptation to the practical needs of the community than is to be expected in the case of the older and more permanent educational establishments. The reactive effect upon the colleges themselves will doubtless be also very beneficial. The theory of the movement is that college professors will do extra-collegiate work; and it is certain that, in addressing more miscellaneous audiences than are wont to be gathered within college walls, they will learn new methods of instruction and discover new springs of influence. College students form a more or less select class, and they are expected not only to follow in an unquestioning manner the lines of study indicated to them, but to accept in the same way whatever may be the special educational views or traditions of the institution they attend. The extension classes will be at once more fluid in their composition and more favorable to initiative and originality on the part of the teacher. There will thus tend to be developed a new type of teaching and new conceptions of the possibilities of intellectual growth. Science will learn—what it has never yet thoroughly learned—to dwell among the people and mingle its life with theirs.

Taking another point of view, we might dwell upon the great need that exists for something that will bring home a touch of true culture and of exact knowledge not so much to the "masses" as to the "classes." Among the latter the fields are "white to the harvest." We are often told that the ignorance of the working classes is a source of danger to the state, but we are by no means persuaded that the ignorance of a somewhat higher social stratum is not a more serious danger. A couple of years ago the most popular clergyman in the United States, addressing his own congregation, recommended those of his hearers who were wealthy to spend their money freely upon every form of expensive luxury—to clothe themselves in the richest fabrics and most expensive furs, to ornament themselves with the costliest jewels, to make their houses gorgeous with everything that was most sumptuous and elegant, to feed themselves with splendid liberality, to conduct themselves in general—so he actually said—as God's favored children, for whom nothing could possibly be too good. In olden times it was said that the poor had the gospel preached to them, and that they heard it

gladly; to-day good news of a slightly different tenor comes to the rich, and how sweet it must be to be told that, being rich, you are presumably a favored child of God, and that in living a life of luxury that might make Dives turn green with envy you are simply carrying out his fatherly designs! But the eloquent preacher told his wealthy hearers more: he assured them that, in thus heaping indulgences upon themselves, they were helping the poor by furnishing them with employment. Of course he believed it, because the whole class to which he belongs, with only here and there an exception, believes it; and that is just where we see the great need for the missionary work of the university-extension system. Here are thousands of high-feeding, richly dressed, gospel-taught people, who, in matters economic, are sitting in the outer darkness of ignorance—silly enough to think that the more they consume on their pleasures the more benefit they confer on the world, the more they lighten the toil of the poor.

But it is not upon economic subjects only that the talk of the so-called educated classes betrays a woful lack of information and of coherent thought. Upon scientific and historical subjects it is much the same. By this time the main axioms connected with the doctrine of the conservation of energy ought to be the common property of all decently educated persons, but we constantly hear well-dressed people talking as if electricity, for example, were a mysterious something derived from a mysterious nothing, and thus constituted a boundless source of energy to be had for the asking. It is needless, however, to multiply examples: the world, in spite of all our educational institutions and perhaps a little through their fault, is full of ignorance in places where one would think ignorance ought not to be; and we may well, therefore, hail with joy the introduction of a scheme which seems likely to bring light and knowledge to many thousands of minds.

Upon one point, however, we find ourselves unable to agree with our contributor. After making out a strong case for the usefulness of university extension, he is disposed to draw the conclusion that the national Government should take it under its protection and sustain it by subsidies. From our point of view this would tend to mar the whole scheme. Its success will depend mainly on the individual zeal and public spirit with which it is conducted; but if there is anything that is fatal to zeal and public spirit, it is a subsidy. What is the cause of the paralyzing lack of vitality in our public schools if it is not that they are part and parcel of a political system? It may be granted at once that a national subsidy would greatly accelerate the movement; but we are convinced that what would be gained in rate of growth would be more than offset by deterioration in the ethical and intellectual quality of the work done. If people do not get knowledge to-day it is not for lack of pecuniary means; it is because they prefer to spend the means they might apply to the purpose to less worthy objects. If there is one feature more than another of the university-extension movement that awakens our interest and commands our sympathy, it is that it offers an opportunity for a true crusade against ignorance and folly. But the crusader and the subsidy-seeker are very different persons. The former may be mistaken, but he is enthusiastic; the latter is rarely mistaken, but his enthusiasm is of a low quality. Now, as we have said, here is a grand opportunity for a crusade—an opportunity to show that those who possess the keys of knowledge are willing to unload their stores for others, and that those who have means in abundance are willing to contribute freely to raise the intellectual and moral standard of society. All the elements of a great movement are present if only we can count on enthusiasm—on some small share of that feeling for duty and that

regard for others which bring Salvationists into the streets with their drums and tambourines. But the opportunity would be thrown away, and the movement would assume a thoroughly commonplace and almost mercenary character, if it were to be fed with the proceeds of taxation. We trust that the leaders of the movement will resolve to have nothing to do with politics save to purify and elevate them by the direct action of sound instruction on the public mind. It will not help our politics a bit to have university extension hanging round the Capitol for an appropriation.

A GROUP OF SCIENTIFIC MEETINGS.

The meeting of the American Association was held this year in the midst of the meetings, beginning August 11th and closing September 1st, of a number of societies cultivating special fields of science, which have grown up out of and around it. The multiplication and division of societies in this way is a natural result of the increasing expansion and specialization of scientific studies in the United States, and one of the most certain signs of them. The fields which one society was able to cultivate have become too large and too many to be adequately tilled by it alone, and it has been found convenient to distribute the details among separate workers, while the old Association remains the central organization and chief, under which the whole is unified. This grouping of meetings promises to be a permanent feature, and to make our annual scientific convention an event of larger and growing interest. The meetings held in advance of the larger meeting were those of the American Microscopical Society, the Society of Official Chemists, the Association of Agricultural Colleges, the Society for the Promotion of Agriculture, a body which is limited to forty members; and the Association of Economic Entomologists. The discussions in these assumed, to a large extent, a practical shape, and aimed directly or indirectly at the advancement of agricultural interests. Among the important features of the meetings were the arrangements that were made for the fusion of the chemical societies of the United States into a single body. Eight societies were represented in the Union, viz.: The American Chemical Society, the Washington Chemical Society, the Association of Official Chemists, the Chemical Societies of Cincinnati, the Brooklyn Institute, the Franklin Institute, the Association of Manufacturing Chemists, and the Louisiana Association of Sugar Chemists. Under the terms of union, which have yet to be approved by the societies separately, the new organization will be called the American Chemical Society, and each local society will retain its identity as a branch. The name of the general society is the best that could be chosen for a body representing the whole country, and gives, besides, a fitting recognition to the oldest and one of the most efficient and active of our chemical associations.

The meeting of the American Association itself was one of the largest and best that have been held in recent years. The number of members reached 653, and was greater than had been recorded since the New York meeting of 1887, when 729 members were registered. Three hundred and seventy-one new members were elected, and 235 papers were entered to be read. Permanent Secretary Putnam has been quoted as saying that the papers read were above the average in interest and importance, and this opinion appears to be well founded. Among the subjects informally talked of as things to which the Association should give the support of its approval and influence were those of the establishment of a fund for the encouragement of scientific research, which was supported by Prof. Brashears and President Prescott; the with-

drawal of certain public timber lands from entry and their protection as forest reserves; and the utilization of the Weather Bureau and the agricultural experiment stations in forming a service of water statistics and the survey of water-supplies to serve as a basis for the application of proper principles of water management. On the invitation of the Australasian Association representatives were appointed to serve on an International Committee to prepare a uniform system of biological nomenclature.

The meeting of the American Association was immediately followed by that of the American Geological Society, which was followed in its turn by that of the International Geological Congress. The former meeting also took on somewhat of an international character, for several of the European geologists were present, and such of them as chose to take part in the proceedings were given the first places. The meeting of the International Congress was the fifth of the triennial series, and was attended by about two hundred members, nearly half of whom were foreigners from Austria, Belgium, Chili, France, Mexico, Peru, Roumania, Russia, Switzerland, Canada. Germany, Great Britain, and Sweden. Profs. James D. Dana and James Hall were designated honorary presidents of this body and Prof. J. S. Newberry president; but he not being able to attend on account of age, the sessions were presided over by one or another of the vice-presidents, Prof. Joseph Leconte presiding at the opening session. The Congress was welcomed by Secretary Noble, in a happily phrased address, in which he spoke of the importance of geology in its scientific and economical aspects, the activity with which its study is pursued in the United States, and the liberality with which it is assisted by the Government. The meetings were varied by the usual number of excursions, ending in a grand excursion of the International Geologists to the Yellowstone Park, the mining districts, the Colorado Cañon, and other points of geological interest in the West.

The American Association has selected Rochester, N. Y., as the place for its meeting of 1892, and the following officers have been chosen for that occasion:

President, Prof. Joseph Le Conte, Berkeley, Cal.; permanent secretary, Prof. F. W. Putnam, Cambridge, Mass.; general secretary, Prof. Amos W. Butler, Brookville, Ind.; council secretary, Prof. T. H. Norton, Cincinnati, Ohio; treasurer, William Lilly, Mauch Chunk, Pa.

Vice-presidents of sections: A, Prof. J. R. Eastman, Washington, D. C.; B, Prof. B. F. Thomas, Columbus, Ohio; C, Dr. Alfred Springer, Cincinnati, Ohio; D, Prof. J. B. Johnson, St. Louis, Mo.; E, Prof. H. S. Williams, Ithaca, N. Y.; F, Prof. S. H. Gage, Ithaca, N. Y.; H, W. H. Holmes, Washington, D. C.; I, Prof. S. Dana Horton, Pomeroy, Ohio.

Secretaries of sections: A, Prof. Winslow Upton, Providence, R. I.; B, Prof. Browne Ayres, New Orleans, La.; C, Prof. J. L. Howe, Louisville, Ky.; D, Prof. O. H. Landreth, Nashville, Tenn.; E, Prof. R. D. Salisbury, Madison, Wis.; F, Prof. B. D. Halsted, New Brunswick, N. J.; H, Dr. Stewart Culin, Philadelphia, Pa.; I, Lester F. Ward, Washington, D. C.

Auditors: Dr. H. Wheatland, Salem, Mass.; Thomas Meehan, Germantown, Pa.

LITERARY NOTICES.

The Question of Copyright. By George Haven Putnam. New York: G. P. Putnam's Sons. Pp. 412.

This convenient and timely book contains a summary of the copyright laws at present in force in the chief countries of the world, together with a report of the legislation now pending in Great Britain, a sketch of the contest in the United States, from 1837 to 1891, in behalf of international copyright, and certain papers on the development of the conception of literary property, and on the probable effects of the new American law. To the author's view, the American act of the present year, providing copyright for aliens, can hardly be accepted

as final legislation, and will doubtless at some no distant date call for further consideration as to some of its provisions. It leaves us still, in recognition of the claims of literary workers, very much behind the other nations of the civilized world. The result of fifty-three years of effort, it brings this country to the point reached by France in 1810, and by Great Britain and the states of Germany in 1836-'37. Under the provisions of the Berne Convention of 1887—which probably represents the final stage of international copyright in Europe—by fulfilling the requirements of their domestic copyright laws, authors can now at once secure, without further conditions or formalities, copyright for their productions in all the states belonging to the International Union. This union comprises nearly all the countries of Europe, with Tunis, Liberia, and Hayti. "It is not probable," says Mr. Putnam, "that another half-century of effort will be required to bring public opinion in the American Republic up to the standard of international justice already attained by Tunis, Liberia, and Hayti."

The Prison Question. By Charles A. Reeve. Chicago: A. C. McClurg & Co. Pp. 194. Price, $2.

This book gives a theoretical and philosophical review of matters relating to crime, punishment, prisons, and reformation of convicts; considers mental, social, and political conditions as they bear upon these things; and presents the author's views about the causes and the prevention of crime and the production of criminals. We do not have to accept the author's views specifically to recognize that he has thought carefully and deeply on the subject, and has reasoned upon it without undue prejudice. The fundamental principles of the book were first presented by him in a public lecture, about twelve years ago, and have been urged in various papers read before the National Prison Congress. The purpose of the book is to group some important well-established facts and apply them to the subjects of prisons and reforms, in such order as will interest so much of the general public as can be reached, and so aid in creating a public opinion that can intelligently and practically deal with and dispose of the defective classes and the causes that produce them. The author believes that an impractical theology on the one hand, and a blind agnosticism on the other, alike operate to prevent a true solution of the problems of criminality. From a false position no step can be taken in advance without plunging into falsities. The only practical steps are such as lead to a true position. These the author tries to point out, by studying the criminal's mind and the factors that operate upon it—among which are physical and mental energy, theology, natural forces, marriage, society, and other surrounding influences—as they tend to develop, restrain, perpetuate, or procreate criminal tendencies. A very important place is given to heredity, and, by consequence, to such regulation of marriage as will best prevent the transmission of criminal appetites. The relations of government, legislation, punishment, and prisons to the criminal are considered; reformation receives a hopeful word; but the measures to which real importance is attached are those that appertain to prevention.

The Sturgeons and Sturgeon Industries of the Eastern Coast of the United States, with an Account of Experiments bearing upon Sturgeon-culture. By John A. Ryder. Washington: Government Printing-Office. Pp. 50, with Plates.

The studies embodied in this monograph were made by the author in the spring of 1888 at Delaware City, Del., a very important center of the sturgeon-fishery. Notwithstanding the results of the effort were in some respects unsatisfactory, a number of novel facts were collected and experiments were carried out which must be of great significance in any further attempts at the artificial propagation of these fishes. The embryological data have been drawn partly from the author's own experiments and partly from the work of other authors. The embryos of the common sturgeon here illustrated are believed to be the first of that species that were ever figured. The important fact was determined that the common sturgeon (*Acipenser sturio*) is the only species which is at the present time of commercial value in the fishery of the Delaware. A few specimens of *Acipenser brevirostris* were obtained—a species which has not been

certainly recognized since Le Sueur's time. The only profitable fishery of the common sturgeon—unless the Florida sturgeon should prove to be of the same form—is on the eastern coast of the Delaware River and Bay. A considerable amount of capital is invested in the business. The experience of the dealers and fishermen shows that a steady falling off has occurred in the catch within a few years. This and other facts prove that it is high time that something was being done to stay the extinction of the fish. The only means of maintaining and increasing the industry is through artificial propagation; and the author has every reason to think that this may be successfully accomplished at a comparatively insignificant outlay.

The Diseases of Personality. By Th. Ribot. Chicago: Open Court Publishing Company. Pp. 157. Price, 75 cents.

The idea of personality is easily handled by metaphysicians who assume an ego. The school of experimental psychology, however, which claims M. Ribot, views this as no simple task, but rather the reward of arduous research. In the present volume, therefore, the author seeks through investigation of those cases in which the sense of personality is disorganized to discover a clew to its nature. In order to know human personality we must analyze it, but it must be remembered that the phenomena separated for purposes of analysis are interdependent. The various disorders of personality may be classified as organic, emotional, and intellectual. The sense of individuality in the normal body, its fluctuations dependent upon alterations in general or local sensibility, the egoistic sense in monsters and twins, show "as the organism, so the personality." Emotional manifestations peculiar to impaired nutrition, sexual aberration, and perversion of the higher instincts are found to confirm the same proposition. Intellectual vagaries of all kinds, due to sensorial derangement, hallucinations, the phenomena of hypnotism and of mysticism, furnish the corollary that ideas are only a secondary factor in changes of personality.

Regarding personality as "the highest form of psychic individuality," the nature of *consciousness* and the *individual* is involved. Instead of the subjective notion that consciousness is "a basic property of soul," M. Ribot finds it "a simple phenomenon superadded to activity of the brain, appearing and disappearing according to circumstances." States of consciousness are coincident with disassimilation of nervous tissue, so that we may predict that they depend upon a certain state of the nervous system But we do not yet understand all of the physiological conditions of consciousness.

If *individual* be defined as that which is not divided, we are obliged to descend very low in the organic world to find an example. "Every protoplasmic mass which attains a few tenths of a millimetre spontaneously divides itself. Protoplasm in the individual state is therefore limited in size." Scientists may find a rudimentary consciousness in the unfolding, absorbing, and dividing of the lowest organism; but M. Ribot considers this an irritability common to living beings, which is developed into the general sensibility of more complex forms. In colonies of *Hydractinia*, or in *Agalmidæ*, where locomotion is centralized, we meet with a coordination which is the germ of personality. Gradually, as the nervous system becomes more prominent, psychic individuality is constituted. In any given time the sum of nervous actions in man will far exceed the sum of the states of consciousness. Thus conscious personality is but an abstract of what takes place in the nervous centers. "Why certain nervous actions become conscious, and which are they?" is yet unanswerable. Different states of consciousness succeed each other and depend upon nervous activity. Pathology confirms the fact that the feeling of the ego changes with the bodily condition. The problem thus becomes biological, and psychology must wait, therefore, for a fuller knowledge of the genesis of organisms.

Studies in Evolution and Biology. By Alice Bodington. London: Eliot Stock. Pp. 220. 50 cents.

A perusal of this book shows extensive reading on the part of the author, and a clear conception of the principles of evolution. Some of the chapters are very interesting. It is difficult, however, to see the purposes of the book: as a help to the

working student it is far too meager, and lacks references to original material; as a popular book for the uninformed it is too condensed to be of much use. At the outset a list of books is given for consultation, and this will strike one as a curious collection for the purpose. In the preface the author says, "I am at a loss to imagine why it is considered almost wrong to write about physical science without having made original experiments." The advantage of having made original experiments leads a writer to greater exactness, and, above all, to appreciate the relative value of statements and facts. Her allusions to the fixed ascidians as being comparatively free from vicissitudes and dangers in contrast with locomotive forms derived from the same stock, is misleading. The helpless creature nibbled at by fishes, infested by extraneous growths, unable to fight or flee, is seriously handicapped in the struggle for existence.

We know of no evidence to show that the duration of life of a species is governed other than by the law of natural selection. An interesting article, by Prof. Verrell (Science, vol. i, p. 303), would have given the author some hints as to the probable cause of the rapid disappearance of the larger vertebrates in past times. An allusion is made to the divergence of the Ainos from the Japanese, whereas the Ainos covered the islands of Japan before the Japanese were crystallized into a nation.

Silly flights of fancy are quite out of place in a serious work of this nature; but the attempt to enliven a dignified discourse by lugging in extracts of poetry or nonsense is peculiarly English, and so must be endured.

The *Progress Report on Irrigation in the United States*, prepared by Special Agent *Richard J. Hinton*, on account of the shortness of time during which the survey had been at work when it was made (sixty-one days), does not include results of the investigation itself, but only the returns of correspondence with experts and persons interested in the subject, invited in order to show the conditions and development of irrigation as applied to the soil for the purposes of cultivation. The large number of letters received shows how extensive and growing is the interest in the subject, and promises that the office of the irrigation inquiry will soon have a record of all that has been done about it. As among our own people, practical irrigation appears to have begun with the Mormon settlement on the Great Salt Lake; but has been practiced by the Indians in Arizona and New Mexico for five hundred years. General irrigation really began in the United States with the foundation of the colony at Greeley in Colorado, in 1870, which was successful at once. Its development, slow till 1880, has been more rapid since then. One of the sequences of its adoption is the appearance of a tendency toward division of large holdings of land and its more or less rapid disposal in small bodies. Another incident is a movement among land, mortgage, and trust companies to form syndicates for developing the water-supply of the plains country, for the purpose, of course, of improving the security for their loans. Horticulture in California is said to be in great part the result of irrigation, as is illustrated in the great fruit farms at Riverside. Much stress is laid upon the value of the "undersheet water" of the Arkansas and Platte and other valleys, the results of the survey of which, by Chief-Engineer Nettleton, are noticed below. The curious fact is mentioned concerning this water that cultivation tends to draw it up. Thus at Fresno, where the first cultivators had to dig fifty feet for it, they now get it at from eight to twelve feet below the surface.

The *Report of Artesian and Underflow Investigation* between the ninety-seventh degree of west longitude and the foot-hills of the Rocky Mountains, presented by *Edwin S. Nettleton*, in response to a call by the Senate, is also a progress report, and relates to work done in November and December, 1890, in parts of Kansas, Nebraska, and Colorado, covering particularly the valleys of the Platte and the Arkansas. Valuable features of the report are the plan and profiles showing in detail the location and relation of the surface of the underground water, as found in rivers, wells, springs, and pools, as well as the elevation of the surface of the country along the line surveyed. There appears to be usually sufficient rainfall in this region during the whole year, if it were

properly distributed throughout the cropping season, to make agriculture reasonably certain without the aid of irrigation; and the people of the country believe that the hot and dry winds have more to do with shortages of crops than lack of rainfall. The capacity of the surface streams being limited (the Arkansas and South Platte are already made to give up most of their water before leaving Colorado), a valuable other resource for irrigation is derived from the use of the subterranean or "undersheet" water, with which the sand and gravel deposits in the river valleys of considerable width and unknown depth are charged. Much of this is obtained by means of open subflow ditches. In other cases it has to be pumped. In regions where this is not available, the people must depend upon deep wells of limited capacity, the storage and immediate use of storm waters, and the flow of artesian wells.

The Journal of the College of Science of the Imperial University of Japan, Vol. IV, Part I—published by a committee of four professors, three of whom are Japanese—contains seven articles on subjects of biology and physiology, all by Japanese writers. All are distinguished by great merit, but are of too technical a character to be susceptible of detailed notice in a popular journal. Prof. K. Mitsukari offers a study on the embryology of the turtle, in which many notable features hitherto overlooked are presented. Mr. Kamakichi Kishinonge describes the pulmonary lamellæ of certain genera of spiders and their development, which he suggests may be from some aquatic arthropod, as limulus. Mr. A. Oka describes a new species of fresh-water polyzoa. A new fungus enemy of the mulberry tree is described by Mr. Nobujiro Tanaka. The Irritability of the Stigma is shown by Mr. M. Miyoshi to have a relation to cross-fertilization. A paper by Mr. Masamaro Inaba on the Development of Suprarenal Bodies in the Mouse contains much of interest to physiologists. All these papers are abundantly illustrated in the highest style of lithographic art, with colors.

In his lecture on *Les Progès de l'Anthropologie* (Paris, De Saye & Son, printers), the *Marquis de Nadaillac* endeavors to refute the theory of evolution. It is no slight testimony to the solid foundation on which that theory has been established in our modern philosophy that so learned and earnest a writer has not been able to add one to the arguments which English students met and answered long ago.

Two studies of general interest in the *American Journal of Psychology* for April are those of Dr. E. W. Scripture on Arithmetical Prodigies and Mr. Herbert Nichols on the Psychology of Time. In his paper on Arithmetical Prodigies, Dr. Scripture first gives an account of the persons themselves, with a bibliography of the subject; and afterward undertakes to make such a psychological analysis of their powers as will help in the comprehension of them, and furnish hints to the practical instructor in arithmetic.

The most important paper in Part XVIII of the *Proceedings of the Society for Psychical Research* is that of Mrs. Henry Sidgwick on the Evidences for Clairvoyance. Other curious studies are those of Baron von Schrenck-Notzing on Thought-transference; Mr. Thomas Barkworth on Automatic Writing; and M. Léon Marrilier on Apparitions of the Virgin in the Dordogne. Prof. William James's Principles of Physiology is reviewed at length by F. W. H. Myers. London.

Dr. *William W. Parker*, of Richmond, Va., endeavors, in a paper on *Instinct in Animals and Intelligence in Man contrasted*, to show that there can be no comparison between the two, but that the matter is one of contrasts and antitheses: that in the animal, intelligence is limited; in man unlimited; that man's highest qualities or perceptions have no existence even in embryo in animals; and that "not one, not a thousand, links can bridge the chasm between the intelligence of animals and the intelligence of man."

Insects and Insecticides, a practical manual concerning noxious insects and the methods of preventing injuries, is designed by the author, *Clarence M. Weed*, who is also his publisher (Hanover, N. H.), for the use of the farmer, fruit-grower, floriculturist, and housekeeper. It has been prepared to furnish these persons with a concise account of the more important injurious insects with which they have to contend, together with a summary of the latest knowledge concerning

the best methods of preventing or counteracting the injuries of the pests. For this the author has drawn from the investigations of our leading entomologists. He has tried to make the discussions of life-histories and remedies plain and simple. The insects are classified according to the plants or parts of plants on which they ravage—as those affecting, severally, the larger fruits, the smaller fruits, shade trees, ornamental plants, and flowers, vegetables, cereal and forage crops, and domestic animals and the household. Price, $1.25.

In *Los Animales Parásitos introducidos por el Agua en el Organismo* (London, Burns & Oates) a full account is given by Dr. Rafael Blanchard of the parasitic animals introduced into the organism by water. The work is of convenient size, is neatly printed and abundantly illustrated, and will be of great value to the Spanish readers for whom it is intended.

Mr. *Edward Trevert*, author of several hand-books on electricity, batteries, and dynamos, has prepared a manual on *Electricity and its Applications*, which is published at Lynn, Mass., by the Rubier Publishing Company (price, $2). It is written to supply a demand which the author finds to exist, particularly among amateurs and students, for more information relating especially to the practical part of the science. It treats (giving facts rather than theories, and avoiding technicalities) of voltaic batteries, dynamos, the electric arc and arc lamp, electric motors, field magnets, armatures, the telegraph and telephone, electric bells, the induction coil, incandescent lamps, electrical mining apparatus, the electric railway, electric welding, plating, and gas-lighting apparatus, other electric inventions, electric measurements, and gives resistance and weight tables and an illustrated dictionary of electrical terms and phrases.

In his *Introduction to Dynamics* (Longmans) Mr. *Charles V. Burton* has included kinematics, kinetics, and statics, because of the difficulty, in writing a book for young students with no previous knowledge of the subject, of making a satisfactory division of it. Absolute systems of units have been used, and the C. G. S. system has been given the most prominent place. Price, $1.50.

In *Optical Projection* (Longmans) a treatise is given of a practical character by Mr. *Lewis Wright* on the use of the lantern in exhibition and scientific demonstration through its entire range. The author has practiced optical projection as a hobby for many years, and in his experiments has discovered many ways of improving the application of the art and enlarging its scope. His treatise is comprehensive, and includes, besides an exposition of the philosophy of projected images, descriptions of the parts of the lantern, and of the lights susceptible of being used with it, and accounts of the demonstrations of the apparatus in representations of experiments in molecular and mechanical physics, physiology, chemistry, sound, reflection, refraction, dispersion, and color of light, the spectrum, interference, polarization, heat, and electricity. Price, $2.25.

A series of studies in History, Economics, and Public Law has been begun by the University Faculty of Political Science of Columbia College, to be conducted under the editorial direction of Prof. Edwin R. A. Seligman. The monographs are to be chosen mainly from among the doctors' dissertations in political science, including only such studies as form direct contributions to science and are works of original research. They will appear at irregular intervals, and will be paged both consecutively and separately. The first of the list to appear is a study by *Walter F. Wilcox* on *The Divorce Problem*. The argument of it is that legal provisions of whatever sort have little direct and permanent influence on divorce. The whole ideal and tendency of our modern civilization are to teach every individual self-direction and self-government. No legal reform can do such work. The main work of the state should be as an educator of public opinion; and law may contribute by holding up a standard of morality in advance of the average standard. Other correctives may be sought in education and the Church, or ethical society. The second paper in the series is *The History of Tariff Administration in the United States*, from Colonial Times to the McKinley Bill, by *John Dean Goss*. The author suggests that if our tariffs had been simply for revenue the problems of the best methods and rates would have been solved long ago; but the adoption of the policy of

protection, the very logic of whose honest application compelled the taxation of an almost innumerable list of articles and the general introduction of *ad valorem* rates, vastly complicated the problem. It has brought in devices to deceive the Government, and "this seems to be the legitimate outcome of any system of *ad valorem* duties," while the introduction of the consignment system has thrown the business of importing largely into the hands of unnaturalized foreigners. But there has been, on the whole, a steady development toward more stringent supervision, regulation, and control over the importer.

The Hon. Andrew S. Draper, State Superintendent of Public Instruction of New York, desiring to get a view of the workings of the Prussian educational system from the observations of an expert, commissioned Mr. *James Russell Parsons*, Jr., an experienced officer of the public schools, on his being appointed United States consul at Aix-la-Chapelle, to examine the schools of the country and report upon them. The fruits of Mr. Parsons's observations are now published in the volume *Prussian Schools through American Eyes*, by *C. W. Bardeen*, Syracuse, N. Y.

Problems of the New Life is the title of a book of essays on social and labor questions by *Morrison I. Swift*, and published by him at Ashtabula, Ohio. The author writes with much ability from the point of view that the social organization is wrong, and a remedy is to be sought by agitation. The first paper is on The Social Ordeal of Christianity, and the burden of it is that the Church has failed to regenerate society. The ethical culture organization is contrasted with it as having recognized the progressive tendency of the time and placed itself in the current with it. In the paper on The Old and the New Life exception is taken to the attention given to mental culture as at the expense of physical development, and the accepted criterions of social esteem are decided to be wrong. Other essays concern Education and Power, The Extension of Culture, Nationalism, The Awakening of the Farmers, The Growing Revolution, etc. The conclusion of the last is that "the death of the old order is declared."

In *Politics and Property, or Phronocracy* (G. P. Putnam's Sons), a compromise is proposed by *Slack Worthington* between democracy and plutocracy. Causes are recognized for the existence of discontent and strife, but it is also seen that they can never be entirely annulled; that poverty can never be eradicated from society any more effectually than disease from the human body. But it can be ameliorated by the timely enactment of intelligent laws. The author opposes both plutocracy on the one hand and socialistic tendencies of all kinds on the other, and advocates a reasonable or conservative position between the two, which he calls Phronocracy, or the rule of reason, prudence, and understanding. He holds that the property rights of men shall, to a reasonable extent, be fully recognized and sedulously protected, but that the masses have grievances that must not be ignored. He further advocates the curtailment of the elective franchise by property and educational qualifications.

The American Citizen (D. C. Heath & Co.) is intended by the author, Mr. *Charles F. Dole*, to supply in part the growing demand for the more adequate teaching of morals in schools, especially with reference to the making of good citizens, and to show in this case the practical application of the precepts to the duties of life. It aims, not merely to state the facts about the government of our country and our social institutions, but also to illustrate the moral principles that underlie the life of civilized men. The work is intended for youth in the higher schools, and for adults who may wish to make a beginning in the study of citizenship; and the author hopes to leave such an impression as to lead his more thoughtful readers to take up a more thorough course of study.

The publication (by Macmillan) of the Encyclopædia Britannica's article on *War* in a separate volume gives the author, Colonel *F. Maurice*, opportunity to insert a few remarks on the probable influence on tactics and warfare generally of the latest improvements in destructive agencies, of which the most important are smokeless powder and the introduction of "high explosives" into shells. The general effect of the former element will probably be to render a defensive position more difficult to approach, while the assailants will continue to be completely exposed to view. The effect of high explosives

will be to put it within the power of field artillery to demolish permanent fortifications in all their forms; and even field defenses, earthworks, and the like, are destined to lose much of their value from this new development. But there are inconveniences in the use of these agents that will to a certain degree compensate for the advantages their possessors will enjoy. Strategy will be affected by the application, because it will be possible to carry out great movements with less regard to the influence of fortresses than was formerly necessary. But the difficulties involved in the constant replacement of material will also seriously affect the system of supply of armies in the field. The change in tactics will tend to favor offense rather than defense. To the amended original article of the Britannica are added an essay on Military Literature—a subject which is declared to occupy a field almost unknown to most English readers—and a list of books "of which it may be useful to know the correct titles."

The little book, *Stumbling-stones removed from the Word of God* (Baker & Taylor Co.), is addressed by its author, the Rev. *Arthur T. Pierson*, not so much to those who accuse and assault the Scriptures as to believers. It is acknowledged that "even the most candid and reverent believer finds in the English Bible some difficulties or hindrances in the way of his understanding, if not of his faith." But, assuming that the error in this case lies in what he mistakes for the truth, as a mirage is mistaken for reality, or in his own vision, the true believer is advised that he "runs no risk in calmly and resolutely examining into any alleged difficulty or discrepancy in the Bible. If one encounters a supposed ghost on a dark night, the best way is to walk up to it and look it squarely in the face. To flee from a supposed apparition may leave a lingering doubt whether the ghostly illusion was a reality or not: a bold touch would have dispelled both the illusion and the doubt."

An edition of *Eight Books of Cæsar's Gallic War* is published by the American Book Company, under the editorial care of Dr. *William Rainey Harper* and Dr. *Herbert Curling Tolman*. Regarding Cæsar's Latin as not excelled by that of any Roman writer in richness and purity, and therefore as of that which most deserves to be studied, the editors have endeavored in this edition to present the facts of the language and illustrate the subject in a manner different from the traditional method. Among the new features of the edition are the indication of the first occurrence of every word by putting it in full-faced type; the insertion of "topics for study," based upon the portion read, after the several chapters; examples of inductive studies and list of topics for investigation; and others touching points of less prominent importance. A life of Cæsar, history of Gaul, Germany, and Britain, and a sketch of the method of Roman warfare, are given in the introduction in continuous narrative.

The Quarterly Register of Current History is a new publication, the purpose of which is to collect, arrange, and preserve notices of all current events of importance, as they are given in the newspapers, for future reference and information. Such matter is of the very kind that every one who would keep himself informed of current events would desire most to have at hand; and yet it is just this kind of knowledge that, immediately its day is over and the newspaper containing it is thrown away, is soonest and most irrecoverably lost. The *Quarterly Register* is intended to remedy this evil and supply the want. The first number contains a review of the whole year 1890. The succeeding numbers will give simply quarterly records. Evening News Association, Detroit, Mich. Price, $1 a year.

Geografia per Tutti (Geography for All) is the name of a fortnightly journal for the diffusion of geographical knowledge, published at Bergamo, Italy, by the Brothers Cattaneo, under the editorial direction of Prof. A. Ghisleri. It is a popular journal, intended to reach the entire reading public and keep them abreast of the latest discoveries. Among the articles in the opening number are some bearing on the interests of Italians in America, as that on New Orleans and the Italian Emigration, and one by Elisée Reclus on the Delta of the Mississippi. Sketches and portraits are also given of the famous Italian travelers, Gaetano Casati and Romolo Gessi.

A Journal of American Archæology and Ethnology, edited by *J. Walter Fewkes*, and

bearing the imprint of Houghton, Mifflin & Co., comes to us from the Hemenway Archæological Expedition. The present number, which is marked Vol. I, contains papers on A Few Summer Ceremonials at Zuñi Pueblo, with seventeen illustrations; Zuñi Melodies, with the music transcribed from the phonograph; and a Reconnaissance of Ruins in or near the Zuñi Reservation, with eleven maps, plans, and illustrations.

In *Educational Papers by Illinois Science Teachers* it is stated that science is not taught in the country schools, for two reasons. The average teacher holds a second-grade certificate, which does not represent any scientific acquirement; and the rural tax-payer is afraid that scientific instruction may cost. In larger villages and cities outside of Chicago an elementary training may be found in high-schools, and occasionally a graded science course is provided from the beginning. A Natural Science Section was formed by the Illinois State Teachers' Association in 1888. The papers published include those read at the sessions of 1889 and 1890. It is emphasized throughout that elementary science can not be taught by memorizing the zoölogical and botanical classifications of text-books. A natural object should be the first study, and generalization can be learned from the attempts to classify actual specimens. Among those easily obtainable are domestic animals, insects, common flowers, leaves, and table-salt. Elementary physics is best studied in the uses of the lever, cord and pulley, wheel, axle, and ventilation of rooms. In the closing essay upon the material for science study it is urged that the phenomena of life, as exhibited in familiar animals, are more interesting to the child than any facts of structure.

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POPULAR MISCELLANY.

Artesian Wells and their Flow.—That part of the definition of an artesian well given by the Department of Agriculture that includes all subterranean waters which, on being reached or opened from above, are found to flow by pressure to a higher level than the point of contact, is accepted by Mr. R. Ellsworth Call, in his preliminary paper on Artesian Wells in Iowa, as complete in itself and as properly defining artesian water. Artesian flows may be variable, that is, may exhibit sometimes increased and at other times decreased flows of water, but the artesian characters are still very marked. Originally all artesian waters are meteoric, that is, are all waters which reach the earth by precipitation as rain. That they shall percolate to lower strata, be included between impervious strata or layers of clay or close-textured rock, is a necessary condition. But the total water thus held in confinement has a definite relation to the catchment basin on the one hand and to the total annual rainfall on the other. It is easily seen, then, that artesian waters may vary with the season; that in dry seasons, when the wells are shallow, they will soonest show decreased flow; that in a series of years when the precipitation is far below the normal the artesian areas may entirely fail, again to present good wells when the fall of meteoric water reaches the normal or rises above it. Wells may then, in a certain sense, be temporary and still be artesian. In the case of the deep wells, those that lie far below the range of variation from causes connected with the variable factors of annual character that mark shallow wells, artesian flows are apt to be more constant; but even here there are certain variable features which show differences through longer intervals of time. No artesian basin exists anywhere, but it will be found necessary, sooner or later, to control, by mechanical means, the total flow or "output" of the several wells. The waters are bound to be exhausted in the long run if there be no well-planned governing relation between the consumption and the known sources of supply. The deepest and the largest flowing wells will sometimes be taxed beyond their "life," and then, for a time at least, they must be allowed to rest. No owner of artesian wells in the glacial districts, where the wells are shallow, can afford to allow his well to flow and the water to be wasted.

Different Effects of Denudation.—Describing the old, or abandoned, fields of the south, Prof. W J McGee spoke, in the American Association, of the different aspects presented by the results of denudation according to the situations of the fields. When the tracts are low or gently undulating, they are quickly clothed with vegetation; but when they are hilly and high, the ravines or deepened gullies invade the hill slopes and uplands, until in some cases the entire soil is washed away and the verdure-clothed surface is transformed into a glaring sand, while the bottom lands, once the most fertile of cotton fields, are clogged with the sand swept from the hills until they, too, are ruined for agriculture. The reasons for this accelerated denudation may be sought for in the relations which geologists have found to exist between the elevation and the configuration of lands, their climatal conditions, and the character of their vegetation. An area standing high above the base level for a considerable period assumes a rugose configuration. There is also a configurative characteristic of the prairie and another characteristic of the woodland, the latter being more rugose; and the geologist trained in this line of investigation can discriminate at a glance between the lands cleared of forests by human agency and those that are naturally grass-covered. The configuration of Mississippi and other parts of the southern United States indicates considerable altitude above base-level and an originally forest-covered condition. The surface slopes are too steep to withstand the action of the storms and streams when the forest covering is removed. It is true that

during the palmy days of the plantations the fields were not eroded, but that was because of the constant use of concentric cultivation, hillside ditches, balks, and other protective devices; but when the fields were abandoned the waters gathered on the hillsides, ran down the slopes, and quickly destroyed the surface. In many cases the destruction has gone so far that to check it would cost more than the value of the land; but when not too far advanced it may be checked by planting Bermuda grass on the steep slopes and locust trees about the heads of the gullies, and by other preventive measures.

The Travels of Weeds.—The term "weed" is a relative one, and, as defined by Prof. Byron D. Halsted, means "only plants that are able to assert their inborn rights above all others and wage a close warfare with man for the possession of the earth. There is nothing in structure, form, or substance that distinguishes a weed from other plants. It lives, grows, and reproduces its kind like all others of its class, and therefore the methods of migration are the same as obtain with those of its kin. The rapidity may be greater because of the dominant weed nature, but the difference is only in degree and not in kind." A large number of our worst weeds came to us from foreign countries; just how they emigrated will never be known in every case. "Some came as legitimate freight; many were stowaways. Some entered from border lands upon the wings of the wind, upon river bosoms, in the stomachs of migrating birds, clinging to the hair of passing animals, and a hundred other ways, besides by man himself. Into the New England soil and south along the Atlantic seaboard the weed seeds first took root. Also, there are wild plants of that region, with a strong weedy nature, developed into pests of the farm and garden. As civilized man moved westward the weeds followed him, reinforced by new native ones that soon vied with those of foreign blood. Not satisfied with this, the natives of the interior ran back upon the trail and became new enemies to the older parts of our land. The conditions for the development of weeds have increased with the development of our country, until now we are literally overrun. Weeds, usually as weeds, go and come in all directions, no less as tramps catching a ride upon each passing freight train than in cherished bouquets gathered by the wayside and tenderly cared for by transcontinental tourists in parlor cars."

The Scharf Library of Johns Hopkins.—The library presented by Colonel J. Thomas Scharf to Johns Hopkins University includes books, pamphlets of great value, and several hundred unpublished manuscripts. Most of the works are historical. The manuscripts include ten by James D. McCabe, formerly of the Confederate War Department; many on revolutionary history, and a large number of a miscellaneous character. Other departments consist of a collection of materials for the history of New York city and vicinity; a collection on early Missouri history; the most valuable of Thompson Westcott's books on Pennsylvania; materials on almost every phase of Maryland history, and more varied and complete materials for the history of Baltimore; a rich mass of documents on southern history, and covering the whole period of the rebellion; about three thousand "broadsides," covering many departments of Revolutionary history, and including specimens of almost every one written or printed in Maryland during the last and the early part of the present century; Confederate and Revolutionary autographs, with the letters to which they are attached, some of them interesting in themselves; and various miscellaneous articles.

Japanese Playing-cards.—The Japanese playing-cards are more distinctly original, according to Mrs. J. King Van Rensselaer, than any others, and show no marks of common origin with them. They are oblong, and are made of pasteboard, with the backs painted black. The designs seem to be stenciled, and are brightly and appropriately colored and then covered with an enamel or varnish, which makes them slippery. They are much smaller than our cards. Forty-nine in number, they are divided into twelve suits of four cards in each suit. One card is a trifle smaller than the rest of the pack, and has a plain white face, not embellished with any distinctive emblem, and is used as a "joker." The other cards are covered

with designs that represent twelve flowers or other things appropriate to the months of the year. Each card is distinct and different from its fellows, even though it bears the same emblem; and they can be easily distinguished and classified, even if they bear the same emblem, by the symbolic flowers they bear, and also by a character or letter that marks nearly every card, and seems to denote the plant that represents the month. The only month that has no floral emblem is August, and that suit is marked by mountains and warm-looking skies.

The Monkey Language.—The results of experiments in the language of monkeys are published by Prof Garner in the New Review. Most of them were made in the United States. He had long believed, he says, that each sound uttered by an animal had a meaning which any other animal of the same kind would interpret at once; and had observed, as most of us have done, that animals soon learn to interpret certain words of man and to obey them, but never try to repeat them. When they reply to man it is in their own peculiar speech. The author began his studies by visiting the zoölogical gardens of the United States and watching and listening to the monkeys in their prattle. By permission of Dr. Frank Baker, of the National Zoölogical Garden, two monkeys which had been caged together were separated and placed in different rooms. A phonograph was arranged near the cage of the female, into which she was made to speak. It was then made to repeat her "words" near the cage of the male. His surprise and perplexity "were evident. He traced the sounds to the horn from which they came, and, failing to find his mate, he thrust his hand and arm into the horn quite up to the shoulder, withdrew it, and peeped into the horn again and again. He would then retreat and again cautiously approach the horn, which he examined with evident interest. The expressions of his face were indeed a study." This satisfied Prof. Garner that the monkey recognized the sounds as those of his mate. He then managed to get some sounds from him which the mate in her turn recognized. The next recorded interviews were with two chimpanzees, from which a fine, distinct record was secured, and with a capuchin monkey in the Cincinnati garden. The author spoke to the monkey in his own tongue, using the word supposed to stand for milk. The monkey "rose, answered me with the same word, and came at once to the front of his cage. He looked at me as if in doubt, and I repeated the word; he did the same, and turned at once to a small pan in the cage, which he picked up and placed near the door at the side, and returned to me and uttered the word again. I asked the keeper for some milk, which he did not have, however, but brought me some water. The efforts of my little simian friend to secure the glass were very earnest, and the pleading manner and tone assured me of his extreme thirst. I allowed him to dip his hand into the glass, and he would suck his fingers and reach again. I kept the glass from reach of his hand, and he would repeat the sound and beg for more. I was thus convinced that the word I had translated milk must also mean water, and from this and other tests I at last determined that it meant also drink and probably thirst. I have never seen a capuchin who did not use these two words. The sounds are very soft and not unlike a flute, very difficult to imitate, and quite impossible to write." Other sounds were detected for solid food or the hunger for it, pain and sickness, and for alarm. On the utterance of the last, the monkey sprang to the highest point in his cage, and on repetitions of it became almost frantic with dread—so that the sound for food would for the time have no inducements for him. These sounds Prof. Garner regards as the constituents of a monkey language which has a variety of dialects, according to the species addressed.

Famous Japanese Swords.—A Japanese short sword exhibited by Mr. Inman Homer before the Numismatic and Antiquarian Society of Philadelphia is distinguished by an inscription on the blade. Mr. Benjamin Smith Lyman said that this inscription was in Japanese characters, and appeared to be the name of the sword. "It is not usual," he said, "for swords to have a name in Japan, but it is sometimes the case, as in Europe. Two famous swords are recorded

in Japanese history—one, called *Hizamane* (the knee-sword), from its being tried upon a convict, and at one stroke severing the knee as well as the neck; and another, called *Higekiri* (beard-cutting), from its cutting through the beard when similarly tried. Another sword is mentioned in the celebrated romance of the memoirs of the Eight Dogs of Satonú and called *Murasame* (Autumn Showers), because it had the magical property of shedding water that kept it free from blood. The sword now exhibited is inscribed with *Osoraku*, which appears to mean 'fearful,' so the sword probably bore the not inappropriate name of 'The Fearful.' Being a short sword, it has no guard, as the short sword was sometimes worn beneath the robe, where a guard would be in the way. Long swords usually have an inscription under the wooden handle, giving the name of the maker and the date. This bears none, but the maker's name is found upon the blade of the small knife inserted into the same scabbard, which is inscribed *Morju Shiro Kanekiyo.* Kanenga was the name of a famous swordmaker, some of whose works are dated from 1321–1323 A. D. A successor of his was Kaneyoshi (1492–1500), and from certain parallel inclined lines which Kaneyoshi used as a distinguishing mark, and found on the part of the present sword concealed by the handle, it seems probable that the maker, Kanekiyo, was a pupil of his, or a not very distant successor, making the sword, therefore, probably over three hundred and fifty years old."

A Chinese View of it.—The Chinese *literati* have now come to the conclusion, according to the North China Herald, of Shanghai, that Western science has been built up from the leaking out of the knowledge possessed by their ancestors to Western men, who cultivated it, improved upon it, and developed it. Hence they argue in favor of accepting foreign science and inventions in China, saying: "We wish to make use of the knowledge of Western men, because we know that what they have attained in science and invention has been through the help that our sages gave them. We have a good right to it. What Europe has done she has done through the help we gave. If we did not exactly give science to Europe, we gave it the fruitful germ which produced it. They have the science of optics, but in our Motsz we find that reflection from mirrors was known in the days of Mencius. The men of the West hold that the earth is round. This was believed also by our poet Chü Yuen, who, in his ode on astronomy, announces this doctrine; and this was not many years after Mencius. This being so, we ought not to be ashamed of the study of Western science. We are the rivals of the Western kingdoms, and it is good policy to use their spears in order to pierce their shields. We ought to train our youth in Western science, so that we may know how best to meet them in the struggle to resist their encroachments."

The Birds of the Farne Islands.—The Farne or Fearne Islands of the coast of Northumberland, England, famous by association with Grace Darling, "the wrecker's daughter," are more noted as the home of countless sea birds which resort there to nest and rear their young. The variety of their features of "cliffs, stacks, and crags, rabbit-warrens and land thickly covered with vegetation, rocks, and sloping beach," admirably adapts them for this purpose. They are not inhabited, except by the lighthouse keepers and their families, so that the birds and the rabbits have them all substantially to themselves. They are attractive spots to visit, and this is best done in the second week in June, when the breeding season of the birds is at its height; in addition to the eggs, which are practically countless, the visitor then has the pleasure of seeing many newly hatched birds. As "the Pinnacles" of the islands are approached, the guillemots are seen occupying in thousands the flat tops, sitting on end, and packed so closely together that to all appearance there is not room for another; "indeed, so dense are the masses, that one can not help wondering how each individual bird can recognize its own egg—for the guillemot lays but one—or, having left it, can force its way back to it again when it has recognized it, more especially as the eggs are placed on the bare rock, without the faintest vestige of a nest. They are pear-shaped, very large for the size of the birds, and the color and markings vary in

different specimens in a most extraordinary manner." Nearly every shelf or projection of the rock, both in the Pinnacles and in the rest of the islands, is occupied by the kittiwakes, whose well-built nests, with their spotted, brown eggs or speckled, downy young, can be easily seen from the tops of the cliffs. "Walking about," says a writer in the Saturday Review, "it is hard to avoid treading on the gulls' eggs, which are placed in rather loosely made nests among the coarse herbage or on the rocks themselves. As the center of the island is reached it is easy to see the nests of the cormorants, which are large, slovenly constructions, composed principally of sea-weed, mixed with pieces of drift-wood, corks off fishing-nets, and other such flotsam and jetsam, the whole covered and made filthy both to sight and smell by the droppings of the birds and remnants of fish. The eggs, which are bluish-green in ground color, are covered with a white, calcareous matter; but, except where freshly laid, look as dirty as the nests. . . . In a comfortable hollow between two rocks we find the nest of an eider duck, and then, within a very short distance, one or two more. These nests are most cozily lined with the brown down which the bird picks from her breast from time to time during the process of incubation, and in which the large, greenish-gray eggs, from five to eight in number, are almost covered." These birds are very tame and approachable. The light and peaty soil of the interior of the island is full of burrows, which are divided between numberless puffins and a few rabbits. "Many of the puffins, curious, pompous-looking little fellows, with large, brightly colored bills, may be seen sitting about on the rocks or flying and swimming round the island, while their partners are below the ground, sitting each on the solitary egg which she has laid at the end of the burrow. In the campion-covered centers of the islands the terns are numberless, and the beach down to high-water mark is covered with their eggs, so that very great care has to be used in walking to avoid treading on them. They are also to be found in large numbers among the sea campion; many are laid on the shingle with little if any pretense of a nest; while others have slight nests, made of bents and pieces of sea-weed. The list of birds breeding on the Farne Islands includes twelve species, and others may be occasionally seen there as visitors. The birds and eggs, which had been exposed to danger of destruction and extermination, have had their existence more and more secured under the wild birds' protection acts passed since 1869; and in 1888 an association of gentlemen interested in ornithology was formed, which has secured a lease of the islands, keeps intruders off, and takes care of the birds.

Wild Life in the Snow.—Snow, remarks in the London Spectator an observer of wild life, generally catches our animals unprepared, and they are put to all kinds of shifts to find food and escape their enemies. The more open and exposed the districts, the greater their difficulties. Where there are thick woods and hedgerows, and, above all, running water, birds and beasts alike can find dry earth in which to peck and scratch, or green things to nibble and water to drink. But on the great chalk downs a snow-storm seems to drive from the open country every living creature that dares to move at all. For the first day after a heavy fall, the hares, which allow the snow to cover them, all but a tiny hole made by their warm breath, do not stir; only toward noon, if the sun shines out, they make a small opening to face its beams, and perhaps another in the afternoon, at a different angle to the surface, to catch the last slanting rays. But soon hunger forces the hares to leave their snug snow-house, and they find their way to the cabbage or turnip gardens. Squirrels, which are often supposed to hibernate, retire to their nests only in very severe and prolonged frosts. A slight fall of snow only amuses them, and they will come down from their trees and scamper over the powdery heaps with immense enjoyment; what they do not like is the snow on the leaves and branches, which falls in showers as they jump from tree to tree, and betrays them to their enemies, the country boys. During a mild winter they even neglect to make a central store of nuts, and, instead of depositing them in big hoards near the nest, just drop them into any convenient hole they know of near. Rabbits also seem to enjoy the snow at first. They

require a dry, bracing atmosphere, and sea-breezes and frosts suit them; and in the morning after a snow-fall their tracks show where they have been scratching and playing in it all night. But after a deep fall they are soon in danger of starving. If there is a turnip-field near, they will scratch away the snow at the roots and soon destroy the crop; if not, or if the surface of the snow is frozen hard, they strip the bark from the trees and bushes. While all the harmless animals are obliged to spend the greater part of the day and night seeking food, their enemies profit exceedingly. The stoats and weasels find that they have only to prowl down the stream-side to catch any number of thrushes and soft-billed birds which crowd the banks where the water melts the snow, and little piles of feathers and a drop or two of red on the snow show where the fierce little beasts have murdered here a redwing and there a water wagtail, or even a water-hen. Water-shrews, water-rats, and otters all dislike frost and snow, more, perhaps, because the streams are frozen and food is more difficult to obtain along the banks, than from any inconvenience the snow causes them. Otters, even if the rivers do not freeze, have a difficulty in finding the fish, which in cold weather sink into the deepest pools, and in case of some species burrow in the mud. So they go down to the sea-coast for the cold weather, and, making their homes in the coast caves or old wooden jetties and wharves, live on the fish of the estuaries. Rats also often emigrate to the coast in snow-time and pick up a disreputable livelihood among the rubbish of the shore. Of all effects of weather, snow makes the greatest change in animal economy in the country-side, and weeks often pass before the old order is restored.

Where Women rule.—At the opening of a paper on the political domination of women in Eastern Asia, Dr. Macgowan refers to the condition of the aboriginal peoples whom the Chinese found on Yellow River on their arrival from Akkad. The Chinese then possessed the rudiments of civilization, of which the aboriginals were then destitute. That this irruption of the Chinese was anterior to the invention of cuneiform writing in Akkad was probable, because of their use of *quipos* or knotted cords in keeping records. These *quipos*, the author said, and not mere tradition, were the base of Chinese archaic annals, and from them the earliest form of Chinese written characters was evolved. Anterior to these *quipos*, judging from certain neighboring tribes, notched sticks were employed. As to the tribes which the Chinese found existing when they reached their future home, the philosopher of Universal Love, Motzu, enunciated views on the evolution of the state and family which are in accord with those of modern anthropologists. Men at first were in the lowest state of savagery; there was no golden age, as depicted by sages and political philosophers, until men felt a necessity of a remedy for the anarchy that prevailed. Some of the practices of self-deformation were remarkably curious—as, for instance, those of drinking through the nostrils, extracting front teeth and substituting dogs' teeth, head-flattening, etc.; the most striking was the attempt to raise a polydactylous race, by destroying all children who came into the world with the usual number of fingers and toes. The author described a number of instances of rule by Amazons, and observed that it is mostly among the aboriginal inhabitants that the chieftaincy of women obtains to this day. There is seldom an age of which one tribe or another does not afford examples; the more primitive the condition of these tribes the slighter is sexual differentiation as regards public governmental affairs. The fables and myths in Greece respecting Indo-Scythian Amazons arose chiefly from rumors respecting tribes of this kind.

The Yourouks.—The Yourouks of Asia Minor, according to a paper by Mr. H. Theodore Bent in the British Association, are a fair race of nomads of Tartar origin, from the north of Persia. They wander on regular lines of pasturage, live in goat's-hair tents, occasionally showing a tendency to sedentary life, and build miserable hovels out of the ruins of the cities. The Yourouk has very little religion, and refuses to adopt the measures desired by the Turkish Government. The people have sacred trees hung with rags, say prayers over their dead, and practice circumcision, but do not carry out

the elaborate system of prayers and washing inculcated by the Koran. They are polygamous, and have wives, or rather slaves, each having her separate occupation in the family life—one minding camels, another the flocks, another the tent arrangements, etc. They have regular communication with the outer world. Greeks from the towns lend money to start them in flocks by what is called an "Immortal contract." Merchants for wool and cattle pay regular visits to the different encampments. Tinkers, the public circumciser, and other periodical visitors go among them spring, summer, and winter. Their utensils are principally of wood—wooden mortars, wooden gloves for reaping, wooden musical instruments, etc., are used. They are clever at getting food from mountain plants and herbs. An excellent substitute for coffee is produced by a species of thistle; and a sweet, somewhat like chocolate cream, is made out of the cone of a juniper tree. Formerly they were very clever in making dyes from mountain herbs, but the introduction of aniline dyes has greatly destroyed their taste.

Animals in the Desert of Gobi.—In respect to its fauna, the Desert of Gobi constitutes a zoölogical district by itself, without its animal world being rich in species. Animals may be found in considerable groups in certain places, as in the mountains and along the rivers and lakes, but they are comparatively rare in the desert itself, where one meets hardly anything but innumerable lizards gliding under his feet. Birds as well as quadrupeds lead a nomadic life, being forced to seek food at places a considerable distance apart. The animals of the desert are, however, not very particular, especially with respect to drink, and some of the small mammals probably do not drink, but satisfy themselves with succulent plants, or the little snow that falls in winter. Among the mammals the wild horse and camel and the argali sheep are worthy of mention. Prejevalsky discovered in Zungaria the horse which has been called by his name, the Kirghiz *kantag*, the Mongol *maké*. It lives in the most inhospitable regions, in groups of five or six individuals. While the existence of a wild horse in central Asia was unknown till the present time, it has been understood from the days of Marco Polo that a wild camel lived there; but none of the authors who have mentioned it, on the authority of the Chinese, had ever seen it, and its existence was doubted by Cuvier It also was seen by the Russian explorer in the neighborhood of Lake Lob and the Desert of Zungaria. The camel prefers sandy spots more or less inaccessible to man. It spreads over a considerably larger area than the wild horse; for, while the latter is cantoned in a single locality of Zungaria, it inhabits the lower Tarrin, the country of Lake Lob, Khami, and the Thibetan Desert of Zäidam. Prejevalsky calls this animal the wild Bactrian camel. While the domestic camel is usually timid, stupid, and indolent, the Gobi camel is distinguished by its vigilance and the extraordinary development of its senses of sight, hearing, and smell. It can run a hundred kilometres without stopping a moment, and can climb mountains with an agility comparable to that of the chamois. Its voice is rarely heard, but is more like that of the bull than that of the domestic camel. The argali sheep is common in the mountainous parts of the Gobi, whence it descends in the spring to feed on the herbage. It adheres to the places it has once chosen, and a mountain spur is often the permanent abode of a whole flock. As it is not troubled by the natives, it has not yet become afraid of man, and passes indifferently by the Mongol camps on its way to water. Among the carnivorous animals of the Gobi are the tiger and the wolf, but the bear has not been seen there, although it is found in the Thian Shan Mountains.

Stolidness of Eskimos.—One of the most remarkable peculiarities of the Eskimos of Cape Prince of Wales, as described by Mr. H. F. Payne, of the Meteorological Office, Toronto, is their sensitiveness to ridicule. It is necessary to put on the gravest expression in dealing with them, else they will refuse to work for or with you, and sulk. While, as a rule, the Eskimo looks upon the white man as born to do him favors, those the author met would sometimes offer payment for their services. If an Eskimo was given an unusually valuable present, he would immediately turn round and ask for the most impossible things, as though he thought

you were now in a good humor and it was the time to get all he could from you. As far as it could be seen, it appeared to be the general belief that all property, especially in the way of food, belonged to everybody in common, and therefore, if you held more than another, it was only because you and your family were physically strong enough to protect it. Few men would, of course, steal from one another when food was plentiful, and thereby make enemies for themselves; "but when food is scarce, might is right," and all make note of the position of their neighbors' *caches* before the winter snow covers them. The Eskimos are exceedingly free, and never consider a man their superior unless he or his family are physically stronger or are better hunters than they. These superior men are treated with little deference, though they are usually sought for in the settlement of difficulties, and act as public executioners.

Central Asian Phenomena.—M. Gabriel Bonvaldt and the Prince Henri of Orleans were received by the Geographical Society of Paris on the last day of January, on the occasion of their return from a journey through the heart of central Asia from the frontiers of Russian Turkistan to Tonquin. They claim to have discovered ranges of mountains, lakes, extinct volcanoes, geysers, and a pass at a height of 6,000 metres, never before explored. Yaks, antelopes, wild horses, and other animals were numerous below 5,000 metres, but birds had disappeared, and there was no vegetation. The travelers and their men and animals suffered greatly from "mountain-sickness." The party went by what is called "the little road" from Thibet to China, which they believed had never been explored. They found well-wooded valleys full of game—meeting twenty-one bears in three days—and often well cultivated and studded with villages; and they crossed the upper waters of several of the rivers of eastern Asia, including, as they supposed, the Yang-tse-kiang. Among the more important features of the country was a hitherto unknown volcanic region. Two isolated volcanoes were named the Pic de Paris and Mont Réclus. A group of other volcanoes gave them reminders of the craters of Auvergne, appearing like tunnels with a small cone in the center. Lava-blocks were numerous, some of them being two cubic metres in dimension. From a distance they might have been taken for yaks. Hot sulphur springs and frozen geysers were numerous. Many minerals were found, including iron and lead. Curious gray monkeys with long hair and short tails were found living among the rocks at the foot of Mont Duplex, but nowhere else.

The Future of the Lobster-fishery.—The experiments begun a few years ago for improving the lobster and cod fisheries of the coasts of Newfoundland promise to be successful. Besides 15,000,000 lobsters hatched and placed in the waters at the Dildo hatchery, 432 floating incubators have been established, at which more than 390,000 lobsters have been hatched. All these would have been lost except for these operations. Lobsters arrive at maturity in five years; and if the useful work now going on is continued year after year, it is evident that the threatened destruction of the lobster can be averted, and the stock in the waters maintained and extended. The cod-hatchery has not been quite so successful, but still the results have been very satisfactory. Fishermen in the neighborhood of Trinity Bay are said to have recently observed large shoals of small cod, which they have not noticed before, from one to two inches long; and this, it is claimed, would be the present size of the fry placed in the waters in June and July last.

NOTES.

A remarkable meteor, found in Arizona, was described by Prof. A. E. Foote, in the Geological Section of the American Association. It was extraordinarily hard, so that a number of chisels were destroyed in cutting it, and the emery wheel used in polishing it was ruined. Cavities were reached in cutting it, which were found to contain diamonds, small and black, and of little commercial value, but of the greatest mineralogical interest. Granules of amorphous carbon were found within the cavity, in which a minute white diamond was revealed by treatment with acid. The general mass of the stone contained three per cent of nickel. Diamonds were previously observed in a meteorite by two Russian mineralogists in 1887.

In the Anthropological Section of the American Association, Mr. William H. Seaman read a paper on the Essentials of Education, with a new classification of knowledge, in which he set forth the changes or modifications in present systems of education required to adapt them to modern ideas. Mr. Walter Hough described the custom of cava-drinking among the Papuans and Polynesians; Major Powell exhibited his linguistic map of North America; Mr. Thomas Wilson described the jade implements from Mexico and Central America, and a collection of ancient gold ornaments from the United States of Colombia; Mr. J. Owen Dorsey discussed the onomatopous types and phonetic types of the Siouan languages; Mr. J. H. Perkins described a collection of stone pipes from Vermont; and Mr. M. M. Snell enforced the Importance of the Science of Comparative Religion.

A connection between tariffs and the distribution of life in the districts which they effect has not hitherto been supposed, but, according to the late D. H. Graham, of Iona, it was free trade brought the rooks to that island. Thus: "Since the ports were opened to the importation of foreign cattle, the rearing of black cattle has been abandoned in those parts of the Highlands; consequently sheep have taken their place, and in Iona, where two years ago you could hardly find a sheep, now you will see scores of them; and whereas two years ago not a rook came to the island, now the hill-pastures are black with them."

A curious trial has recently taken place in London, in which an American named Pinter was prosecuted for an attempt at cheating by pretending to manufacture gold. The accused man set up in defense that he really possessed a secret by which he could increase the bulk of a mass of gold. It was alleged by the prosecution that he once did increase a piece of gold by placing a black powder in a crucible, and it was asserted that the powder must have contained gold. The accused asked the magistrate if he had ever known gold to float. Some of the powder being tested on water floated. This result was afterward said to have been produced by mixing lampblack with the powder and making it too greasy to sink quickly. The accused pretends to more power than the old alchemists, for they only assumed to turn other substances into gold, while he pretends to make it outright.

Dr. Carl Peters relates in his book on Africa that he came to a place where the natives on one bank of a broad river communicate with those on the opposite side by speaking with voices hardly raised, "and yet each side can perfectly hear what the other says." Dr. Peters says that Bishop Hannington was killed, not because he was a Christian, but because he insisted on approaching Uganda from the east. The Waganda have an old prophecy according to which an expedition from the east is to "eat up" the land and make an end of the dynasty of the Wakintu. Accordingly the approach from the east has been strictly forbidden.

The Philadelphia Zoölogical Gardens were visited during the year ending in April last by 211,884 persons, or 3.719 fewer than visited them in the previous year; giving an average of 581 daily admissions. The superintendent's report embodies the important remark that the attention of all institutions devoted to zoölogical pursuits is being directed more strongly each year to the rapid destruction of many of the more valuable and important animals of our native fauna, and to the need for immediate adoption of every means that can be employed to save them from complete extinction. In furtherance of this object increase in the capacity of zoölogical gardens is important, in order that room and facilities may be provided for their increase and growth, secure against improper crossing and inbreeding.

Besides the active enemies which are continually seeking to destroy earth-worms, these animals have a habit of seeking destruction on their own account. On any wet morning the shallow puddles in the roadways and elsewhere are often occupied by the dead bodies of earth-worms, or by individuals at their last gasp. Have these worms voluntarily sought a watery grave? or do they represent, as Darwin thought, merely the sickly and dying individuals that have been washed out of their burrows by the rain? Darwin's explanation is probably true, but it is also credible that the heating of the puddles by the sun's rays has something to do with the great mortality of the annelids. Cold fresh water seems to be practically harmless, though salt water is rapidly fatal to earth-worms.

An illustrated account of the drawings of aboriginal origin that are found in caves in different parts of the United States, prepared for Appletons' Annual Cyclopædia for 1889, has been sent us in a separate pamphlet by the author, Mr. T. H. Lewis. The designs include figures conventionalized from the forms of man, the hand, fishes, serpents, an elk, a face, birds, and combined figures. It is suggested by the editor of the Annual Cyclopædia that one of them may be intended to represent a family or tribal ensign.

In a paper read before the Medical Society of Virginia, Dr. W. W. Parker, of Richmond, favors burial rather than cremation on grounds of convenience and economy; natural sentiment, whereby we cling to every vestige of the body in which dwelt the soul of the dear one; the sentiment of affection, which wants to know the exact spot where the body lies; and religious motives.

The reports of the United Kingdom Temperance and General Provident Institution are regarded by Dr. J. J. Ridge as affording evidence of increasing weight and conclusiveness to the value of temperance as a factor in longevity. For the last year the actual claims upon the Institution for relief were, in the temperance section, 71·06 per cent; in the general section, 100·2 per cent of the expected claims. A summary of five quinquennial returns, or for twenty-five years, shows that while in the general section the deaths have fallen short of the expected number by 242, in the temperance section the deaths are 1,470 fewer. The fact that in the general section the deaths are below the healthy male average proves that the difference between the two sections is not due to excessive drinking on the part of any considerable number of the general section. The comparison is therefore fairly between abstainers and moderate drinkers, and goes to show that the use of alcoholic liquors produces degeneration of the tissues and shortens life.

Some habits of crocodiles are described by M. Voeltzkow, who observed the animals in Vituland. Seventy-nine newly laid eggs were obtained from a spot six paces in diameter which had been cleared of plants, apparently by the crocodile having wheeled round several times. The eggs lay in four pits, dug in the hard, dry ground, about two feet obliquely down. According to the natives, the crocodile, having selected and prepared a spot, makes a pit in it that day, lays twenty or twenty-five eggs in it, and covers them with earth. The next day, it makes a second pit, and so on. It remains in the nest from the beginning, and sleeps there till the young are hatched, in about two months, at the setting in of the rainy season.

A paper by Prof. William Frear, in the American Chemical Association, dealt with differences in composition in the European and the American chestnut. European chestnuts transplanted to this country lose their peculiarities in some degree, but American chestnuts also exhibit wide differences in different years.

The question of the relative influence of animal and vegetable diet on the animal temperature has never, according to the Lancet, been investigated in the human species on a sufficiently comprehensive scale to be of any value; but such comparative facts as throw light on the matter tend to indicate that vegetable feeders, among the lower creation, have a high temperature. The evidence, however, does not seem to be uniform to this point, and it is suggested that some of the apparent discrepancies may be due to the nature of the clothing of the skin. A correspondent of the Lancet and his wife have for about three years been living chiefly on fruit and vegetables, with a little milk and its products, eggs and cheese, and without alcohol, and find that they live as healthily as before, at a lower expenditure of energy. If it be proved that a minimum of animal diet will support life efficiently under reduced combustion and reduced waste of material, "a valuable as well as curious fact will be added to our practical knowledge."

The limit of a man's power to do without sleep has been the subject of curious experiments. Lord Brougham once tried it on himself, and, beginning Monday morning, kept awake till Tuesday night, when he fell asleep on seating himself while trying to dictate to an amanuensis. The recent competition of six men in Detroit, in trying to postpone sleep for seven days, is in point. Beginning on Monday noon, March 30th, four of the men failed before Thursday. A fifth kept up till Sunday morning, had a hard struggle with his sleepiness all through the day, and succumbed at midnight. The sixth completed the time and was conducted to the stage and introduced to the spectators, but was sound asleep before the introduction was over. It is said, however, that these men were allowed to sleep in fifteen-minute naps at the end of their several vigils, and it is added that they suffered no permanent ill.

According to Brandis's Wald in der Vereinigten Staaten von Nord America, forest vegetation is much richer in North America than in Europe, and comprises 412 species—of which 176 are native to the Atlantic region, 106 to the Pacific, 10 are common to both, 46 to the Rocky Mountain region, and 74 are tropical species near the coasts of Florida—as against 158 species in Europe. Six North American species of forest trees—the red-bud or Judas tree, persimmon, hackberry, plane tree, hop hornbeam, and chestnut—are also indigenous in Europe, all now growing there naturally south of the Alps. And since many American forest genera existed in Europe in Tertiary times, while only five European forest genera (*Ceratonia*, *Laburnum*, *Olea*, *Syringa*, and *Laurus*) are not found in America, it is possible that other species formerly common to both countries were destroyed in Europe north of the Alps by the Glacial epoch.

A parliamentary report shows that ether is now used to a considerably large extent in Ireland to produce intoxication. It is preferred to whisky because it is cheaper and more effective. Its effects are described as arousing combative instincts and producing a high state of exhilaration accompanied by shouting and singing and the use of provocative words. Even children are accustomed to it, and come to school smelling of it.

DMITRI IVANOWITSH MENDELEEFF.

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THE RISE OF THE POTTERY INDUSTRY.

By EDWIN ATLEE BARBER.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. X.

FOREIGN writers would have the world believe that the United States can boast of no ceramic history. Even our own chroniclers have, singularly enough, neglected a branch of our industrial progress which is not altogether insignificant nor devoid of interest. On the contrary, it can be shown that the fictile art is almost as ancient in this country as in Great Britain, and has been developed in almost parallel lines.

The first European settlers found the American natives proficient in the manufacture of earthen vessels, and we would not be justified in supposing, even in the absence of documentary evidence, that our ancestors were more ignorant of the useful arts than the Atlantic Coast Indians, who, less cultured than the prehistoric mound builders and the Pueblo races of the West, were in possession of rude, but often ornamental, utensils made of baked clay and sand.

Primitive potteries for the production of earthenware on a small scale were operated in the provinces at an early period, but as only the coarser grades of ware were needed by the simple inhabitants of a new country, no extended accounts of them appear to have been written by the older historians. As early as the year 1649, however, there were a number of small potteries in Virginia which carried on a thriving business in the communities in which they existed; and the first Dutch settlers in New York brought with them a practical knowledge of potting, and are said to have made a ware equal in quality to that produced in the ancient town of Delft. Prof. Isaac Broome, of the Beaver

Falls Art Tile Works, informs me that the remains of an old kiln fire-hole, saved from the ravages of time by being thoroughly vitrified, still exist a mile or two below South Amboy, N. J. This is a relic of the earlier pottery ware made on this continent, and was most probably established by the Dutch to make stew-pans and pots.

Dr. Daniel Coxe, of London, proprietor, and afterward governor, of West Jersey, was undoubtedly the first to make white ware on this side of the Atlantic. While he did not come to America himself, he caused a pottery to be erected at Burlington, N. J., previous to the year 1690, through his agent, John Tatham, who, with Daniel Coxe, his son, looked after his large interests here. It is recorded that in 1691 Dr. Coxe sold to the "West New Jersey Society" of London, consisting of forty-eight persons, his entire interests in the province, including a dwelling-house and "pottery-house" with all the tools, for the sum of £9,000 sterling. We are indebted to Mr John D. McCormick, of Trenton, N. J., for calling attention to the following reference to this pottery, supposed to have been written about 1688, in the Rawlinson manuscripts in the Bodleian Library at Oxford, England: "I have erected a pottery att Burlington for white and chiney ware, a greate quantity to ye value of £1200 have beene already made and vended in ye Country, neighbour Colonies and ye Islands of Barbadoes and Jamaica where they are in great request. I have two houses and kills with all necessary implements, diverse workemen, and other servants. Have expended thereon about £2000." * It is possible to gain some idea of the nature of this "white and chiney ware" by examining the statements of Dr. Plot, a contemporary, who published his Natural History of Staffordshire two years before, as quoted by the late Mr. Llewellynn Jewitt, in his Ceramic Art of Great Britain: "The greatest pottery they have in this country is carried on at Burslem, near Newcastle-under-Lyme, where for making their different sorts of pots they have as many different sorts of clay . . . . and are distinguish't by their colours and uses as followeth:—

"1. *Bottle clay,* of a bright whitish streaked yellow colour.

"2. *Hard fire clay,* of a duller whitish colour, and fully intersperst with a dark yellow, which they use for their *black wares,* being mixt with the

"3. *Red Blending clay,* which is of a dirty red colour.

"4. *White clay,* so called it seems, though of a blewish colour, and used for making yellow-colour'd ware, *because yellow is the lightest colour they make any ware of.*" †

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* MS. Rawlinson, c. 128, fol. 39*b*.

† Page 97, vol. i, London, 1878.

In 1685 Thomas Miles made a white "stone-ware" of pipe-clay procured at Shelton. A few years after this, it is said that a potter named Astbury made "crouch" and "white stone" ware in the same town, on which he used a salt glaze.* It is probable that the "chiney" of the Burlington pottery was in reality a cream-colored ware or a white stone-ware somewhat similar to that made about the same time in England. It is not unlikely that the clay was brought from South Amboy, as Dr. Coxe owned considerable land in that vicinity. This clay has since been extensively employed in the manufacture of fine stone-ware.

Among the immigrants of the seventeenth century were potters who had learned their trade in the mother country, and Gabriel Thomas, who came from England, states in his Description of Philadelphia, published in 1697, that "great encouragements are given to tradesmen and others. . . . Potters have sixteen pence for an earthen pot which may be bought in England for four pence."

It has heretofore been generally believed that the first bricks used in the erection of houses in this country were imported, but it is more than probable that by far the greater proportion were made here. Daniel Pegg and others manufactured bricks in Philadelphia as early as 1685, and within a few years after that date numerous brick-yards were in operation along the shores of the Delaware. Many residences throughout the country, particularly in certain sections of Pennsylvania, were built of brick early in the eighteenth century. The cost of importing these supplies from England and transporting them to the rural districts, far removed from tide-water, would have been prohibitory. That building-bricks were extensively manufactured here previous to 1753 is indicated by a statement of Lewis Evans, of Philadelphia, who wrote to a friend in England in that year: "The greatest vein of Clay for Bricks and Pottery begins near Trenton Falls, and extends a mile or two in Breadth on the Pennsylvania side of the River to Christine; then it crosses the River and goes by Salem. *The whole world cannot afford better bricks than our town is built of.* Nor is the Lime which is mostly brought from White Marsh inferior to that wherewith the old castles in Brittain were formerly built."

When burned, as formerly, in "clamps," the bricks formed their own kiln, piled on edge, a finger's breadth apart, to allow the heat to circulate between. Those which came in direct contact with the wood-fire in the kiln were blackened and partially vitrified on the exposed ends; while the opposite extremities,

* This was made of tobacco-pipe clay mixed with flint, and was superior to anything produced before.

which were farthest from the heat, were only partially burned, and consequently too soft for external use. The other bricks in the kiln which were uniformly surrounded by heat came out red. To utilize all the bricks produced, the black ends of the former were laid outward in the wall, thus combining utility with ornamentation. Many of the older houses were constructed in this manner. An old building on the Brandywine, near West Chester, erected in 1724, was built of bricks made on the property from clay found in the vicinity. The structure was considered an imposing one in its day, and the walls are still standing, in an excellent state of preservation. The annexed drawing will convey a good idea of the manner of laying the bricks in a wall where the red and black varieties were used, known as the Flem-

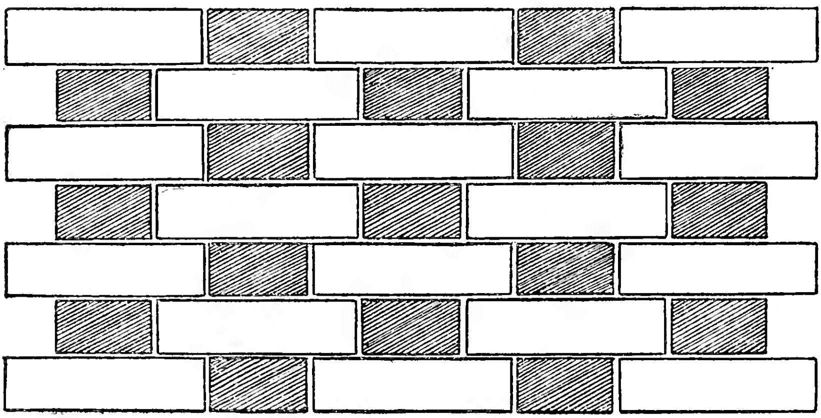


Fig. 1.—Flemish Bond.

ish bond, in which the binders and stretchers alternated, each layer breaking joints with that above and below.

Roofing tiles were also manufactured in this country more than a hundred years ago. Plain tiles were made of ordinary brick clay, about five eighths of an inch in thickness and six and a half to seven inches wide by thirteen to fourteen in length. They were fastened to the rafters of the roof by means of a clay knob or hook at the upper margin of the under side. The surfaces were broadly and shallowly grooved to carry the water off. Such tiles are still found in the *débris* of an old smithy which was built in 1799 at Cope's Bridge on the Brandywine. Other examples, made in Lancaster County, Pa., one of which bears the date 1769, have recently come to light.

A stone-ware factory was started in New York, at "Potter's Hill," near the "Fresh-water Pond," back of the City Hall, in or about 1735, by John Remmey, who came from Germany. The business passed through three generations, all of the same name,

and was discontinued about 1820. Later on, John Remmey, great-grandson of the above, moved to South Amboy, N. J., and established a pottery there.

Previous to the middle of the last century, and before the manufacture of porcelain had been attempted in America, English potters were using china clays procured in this country. Mr. Jewitt, in his Ceramic Art of Great Britain, informs us that a patent was taken out in 1744, by Edward Heylyn, of the parish of Bow, in the county of Middlesex, merchant, and Thomas Frye, of the parish of West Ham, in the county of Essex, painter, for the manufacture of china-ware; and in the following year they enrolled their specification, in which they state that the material used in their invention "is an earth, the produce of the Chirokee nation in America, called by the natives unaker."

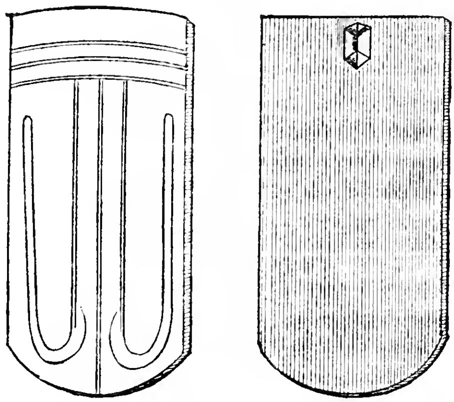


Fig. 2.—American Roofing Tiles (eighteenth century).

In 1878 and 1879, Mr. William H. Goss, proprietor of the extensive porcelain works at London Road, Stoke-on-Trent, contributed to the English Pottery and Glass Trades' Review a series of notes on Mr. Jewitt's work. In December of the former year he wrote: "The specification of this patent is of startling interest. Who would have thought, until Mr. Jewitt unfolded this document to modern light, that the first English china that we have any knowledge of was made from American china-clay? Let our American cousins look out for, and treasure up lovingly, specimens of the earliest old Bow-ware after learning that." Then follows the specification in full as given by Mr. Jewitt, and Mr. Goss continues: "This 'unaker,' the produce of the Chirokee nation in America, is decomposed granitic rock, the earth or clay resulting from the washing being the decomposed felspar of that rock. It is curious that it should have been imported from among the Chirokees when we had mountains of it so near as Cornwall; unknown, however, to any 'whom it might concern' until Cookworthy discovered it twenty-four years later than the date of the above patent." William Cookworthy was acquainted with American clays as early as 1745, for in a letter to a friend dated fifth month, thirtieth, of that year, quoted by Mr. Jewitt, he writes: "I had lately with me the person who hath discovered the china-

earth. He had several samples of the china-ware of their making with him, which were, I think, equal to the Asiatic. 'Twas found in the back of Virginia, where he was in quest of mines; and having read Du Halde, discovered both the petunse and kaulin. 'Tis the latter earth, he says, is the essential thing towards the success of the manufacture. He is gone for a cargo of it, having bought the whole country of the Indians where it rises. They can import it for £13 per ton, and by that means afford their china as cheap as common stoneware. But they intend only to go about 30 per cent under the company."

We must not conclude from this statement that the ware which Cookworthy had seen had been made in America. It is much more probable that the pieces were some of those produced at the Bow works, within the year that had just passed, from the recently discovered American materials.

Not until 1769 was there any serious attempt made to manufacture fine porcelain on this side of the water. In Watson's Annals of Philadelphia we find the brief statement that "the desire to encourage domestic fabrics gave rise, in 1771, to the erection of a flint-glass manufactory near Lancaster, by which they hoped to save £30,000 to the province. A china factory, too, was also erected on Prime Street, near the present Navy Yard, intended to make china at a saving of £15,000." In a foot-note the author adds: "This long row of wooden houses afterwards became famous as a sailors' brothel and riot-house on a large scale. The former frail ware proved an abortive scheme." Mr. Charles Henry Hart, of Philadelphia, made the interesting discovery, a few years ago, of some old advertisements in the newspapers of that time which threw considerable light on this early American enterprise, and he has kindly placed at my disposal the results of his investigations. The first of these announcements, which appeared in the latter part of the year 1769, is as follows:

New China-ware.—Notwithstanding the various difficulties and disadvantages, which usually attend the introduction of any important manufacture into a new country, the Proprietors of the China Works, now erecting in Southwark, have the pleasure to acquaint the public, they have proved to a certainty, that the clays of America are productive of as good Porcelain, as any heretofore manufactured at the famous factory in Bow, near London, and imported into the colonies and plantations, which they will engage to sell upon very reasonable terms; and as they purpose going largely into this manufacture as soon as the works are completed, they request those persons who choose to favor them with commands, to be as early as possible, laying it down as a fixed principle, to take all orders in rotation, and execute the earliest first; dealers will meet with the usual encouragement, and may be assured, that no goods under Thirty Pounds' worth, will be sold to private persons out of the factory, at a lower advance than from their shops. All workmen skilled in the different branches of throwing, turning, modelling, moulding, pressing, and painting, upon application to the Proprietors, may

depend on encouragement suitable to their abilities; and such parents, as are inclined to bind their children apprentices to either of these branches, must be early in their application, as only a few of the first offering will be accepted, without a premium; none will be received under twelve years of age, or upwards of fifteen. All orders from the country, or other provinces, inclosed in letters, post paid, and directed to the China Proprietors in Philadelphia, will be faithfully executed, and the ware warranted equal to any, in goodness and cheapness, hitherto manufactured in, or imported from England.

Subsequently the proprietors advertised for bones, offering twenty shillings per thousand "for any quantity of horses or beeves shank-bones, whole or broken, fifteen shillings for hogs, and ten shillings for calves and sheep (a proportionable price for knuckle bones) delivered at the china factory in Southwark"; concluding with the announcement that the capital works of the factory were then completed and in full operation. The projectors of this enterprise were Gousse Bonnin, a foreigner, who had most probably learned his trade at Bow, and George Anthony Morris, of Philadelphia. In January, 1771, they applied to the Assembly for pecuniary assistance, in the form of a provincial loan, the petition being given in full by Colonel Frank M. Etting in his History of Independence Hall. In their address it is stated that the petitioners "have expended great sums in bringing from London Workmen of acknowledged Abilities, have established them here, erected spacious Buildings, Mills, Kilns, and various Requisites, and brought the Work, we flatter ourselves, into no contemptible Train of Perfection." Whether they were successful in securing the loan does not appear, but later in the same year they advertised for zaffer or zaffera, without which they could not make blue ware. In April, 1772, they advertised for apprentices to the painting and other branches, and shortly after for flint glass and "fifty wagon loads of white flint stone." The attempt, however, proved a failure in a financial point, and in the latter year the proprietors made a public appeal for charity for the workmen who had been brought to a strange country and were left without means of support. After running about two years the factory was closed, the real estate was sold, and Bonnin returned to England.

Little is known of the ware made here. The fact that zaffer was used shows that blue decorated ware was made. The Bow works at that period turned out little but blue and white china, as was the case with all of the early English factories, which employed lapis lazuli and zaffer to color beneath the glaze.

The terra-cotta works owned by Mr. A. H. Hews, at North Cambridge, Mass., were founded by his great-grandfather, Abraham Hews, at Weston, Mass., some time previous to 1765. At first only the ordinary household utensils of earthenware were

made and sold in exchange for general merchandise. After several changes in the firm name, the business descended to the present proprietor in 1865, and five years later was transferred to its present location, where it is said that more flower-pots are produced than at any other factory in the world. Here also are made the usual line of fancy garden terra-cotta and a large variety of art pottery for decorators.

Toward the latter part of the last century potteries for the manufacture of earthen and stone ware had become numerous throughout the States. During the Revolutionary period considerable china was imported from India, Holland, and England for the use of the wealthier citizens, but pewter utensils were also much in vogue. The common people used earthenware, generally red pottery, on which the first attempts at decoration were made with yellow slip. Dishes and flower-pots, with pie-crust edge and rude floral designs or dates, were common (see Fig. 17).

Before the beginning of the present century several stone-ware and earthenware potteries were started in Connecticut. In 1791 John Curtis was making a good quality of pottery in Philadelphia from clay obtained where the brewery now stands at Tenth and Filbert Streets, and his name is found in the directory as late as 1811 in the same business. In the former year Andrew Miller also made earthenware in the same town, and continued the business until 1810, when it passed into the hands of Abraham and Andrew Miller, Jr., who carried on the business jointly for about six years. In 1824 Abraham Miller displayed, at the first annual exhibition of the Franklin Institute, "red and black glazed tea-pots, coffee-pots, and other articles of the same description. Also a sample of platinated or lustre pitchers, with a specimen of porcelain and white ware, all of which exhibited a growing improvement in the manufacture, both in the quality and form of the articles." Quoting from the report of the committee: "It is but a few years since we were under the necessity of importing a considerable proportion of this description of ware for home consumption, but since our potters have attained the art of making it equal, if not superior, to the imported, and as cheap, they have entirely excluded the foreign ware from the American market." Miller continued to manufacture a fine grade of earthenware, such as plates, vases, and ornamental flower-pots, until 1858, but we can not discover that he carried the manufacture of porcelain beyond some successful experiments.

John and William Norton established a pottery in Bennington, Vt., in 1793, for the production of red ware, which was discontinued about 1800, when the manufacture of stone-ware was substituted. This ware has been made continuously ever since, the business being now carried on by Messrs. Thatcher and Nor-

ton, the latter a great-grandson of John Norton, one of the founders.

A "china" manufactory existed in Philadelphia ninety-one years ago, but very little is known regarding it. A friend has recently shown me a letter, dated August 14, 1800, written by a merchant of that city to his wife, who was then visiting in New Jersey, in which occurs the following interesting bit of news: "On account of a man being murdered at the *China Factory* on Monday evening last, a block maker by trade, a number of the same profession, with Rope makers and Carpenters, assembled and on Tuesday evening began to pull down the buildings; they continued at their work till yesterday mid-day,—it was pulled down by Ropes in spite all the Squires and Constables that could be collected—say every house, only leaving the Chimneys standing." The writer, an ancestor of the present owner of the letter, was in business at that time near Fourth and Chestnut Streets, and we are led to infer that the factory was somewhere in that neighborhood. All white ware at that time was known as *china*, and the term was evidently applied to queen's-ware—certainly not porcelain.

Paul Cushman had a stoneware factory at Albany, N. Y., in the first decade of this century, and some examples of his ware are now in the possession of Mr. S. L. Frey, of Palatine Bridge, N. Y., one of which bears the inscription, impressed on the surface of the jar, and twice repeated around the body, "Paul Cushman Stone Ware Factory 1809 Half a Mile West of Albany Gaol."

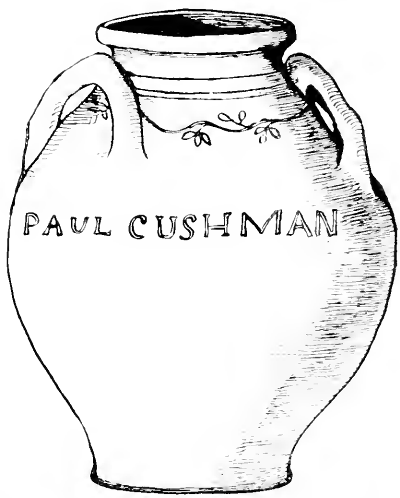


FIG. 3.—ALBANY STONE-WARE. (Collection of Mr. S. L. Frey.) Made about 1809.

In 1812 Thomas Haig, from Scotland, established a pottery in the Northern Liberties, Philadelphia, where he made red and black ware. At the Franklin Institute exhibition in 1825, articles made at this pottery were considered, "in the opinion of the judges, better than goods of the same kind brought from England." The pottery is still operated by Thomas Haig, a son of the founder, who is now in his eightieth year.

Queen's-ware was probably first made in the United States about 1800. Eight years later the Columbian pottery, on South Street, between Twelfth and Thirteenth, in Philadelphia, was

turning out white ware which was claimed to be equal in quality and workmanship to the best made in Staffordshire. Two years later Captain John Mullowney, brick-maker, was operating the Washington pottery on Market Street, west of Seventeenth; and in the files of the Aurora or General Advertiser, published in Philadelphia in 1810, this factory advertised red, yellow, and black coffee-pots, tea-pots, pitchers, etc., and called special attention to the decorating branch, artists being employed who were prepared to put any device, cipher, or pattern on china or other ware at the shortest notice.

Daniel Freytag was making in Philadelphia, in 1811, a finer quality of china-ware than had yet been produced in the United States. It was made of various colors, and was embellished with gold and silver; and in 1817 David G. Seixas manufactured an imitation of the Liverpool white crockery from native American clays with great success, continuing the business until 1822.

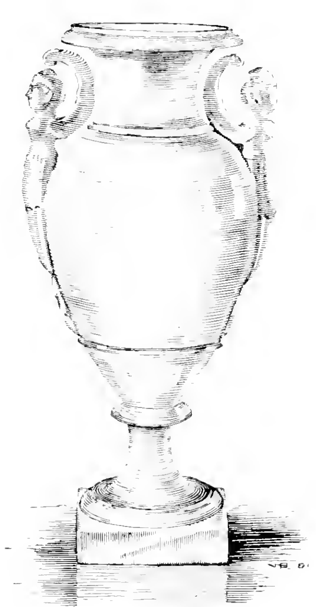


Fig. 4.—Porcelain Vase. New York, 1816.

Porcelain was made in New York city early in this century, probably by Dr. Mead. How long this factory was in operation is not known, but it is believed that a fine grade of ware was made there from American materials. A vase over a foot in height, of excellent body and exceedingly white glaze, is preserved in the Franklin Institute. This was "finished in New York in 1816," and is supposed to have been made at that factory. It is entirely devoid of gilding or coloring, and is made in two parts, held together by a screw and nut, after the French manner.

In 1823 Henry Remmey, a brother of John Remmey, the last proprietor of the New York stone-ware factory, which was closed about 1820, came to Philadelphia and embarked in the same business, which is now continued by a great-grandson, Mr. Richard C. Remmey, who now owns the largest stone-ware works in the United States. Here are manufactured fire-bricks of superior quality, and chemical stone and porcelain ware of every description, some of the vessels having a capacity of two hundred to five hundred gallons. In addition to these specialties, the factory produces a large line of household utensils, and the business has grown to such proportions that the ten large kilns are taxed to the utmost.

No considerable progress was made in the manufacture of porcelain in the United States until William Ellis Tucker, of Philadelphia, began his experiments. From 1816 to 1819 his father, Benjamin Tucker, had a china shop on the south side of Market Street, at No. 324, then between Ninth and Tenth Streets, near

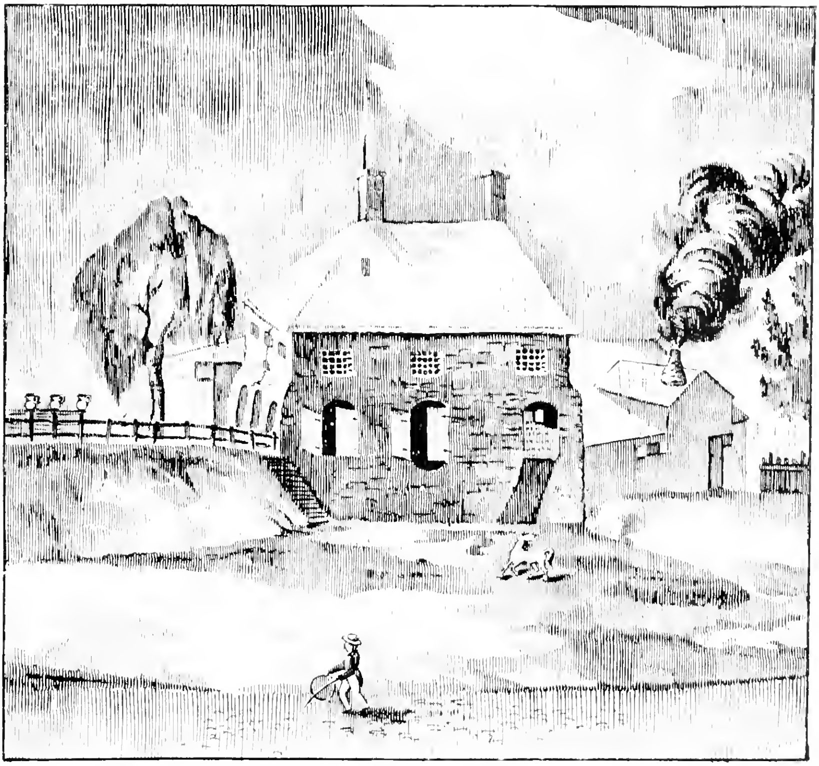


FIG. 5.—TUCKER & HEMPHILL'S CHINA FACTORY. Philadelphia, 1832–'38. (From a vase owned by Mrs. Thomas Tucker.)

where the new post-office building now stands. During this period Mr. Tucker built a small decorating kiln in the rear of his store for the use of his son, who employed much of his time in painting the imported white china and firing it in the kiln. These attempts were at first only partially successful. He then commenced experimenting with different clays, which he procured in the vicinity of the city, to discover the process for manufacturing the ware itself. These experiments resulted in the production of a fair quality of opaque queen's-ware. He then directed his attention to kaolin and feldspar, and finally succeeded in discovering the proper proportions of these ingredients, in combination with bone-dust and flint, necessary for the production of an excellent grade of natural or hard porcelain. Having secured a translucent

body of great hardness, density, and toughness, capable of withstanding extreme changes of temperature, he first seriously began the manufacture of the ware for the market in the year 1825. The old water-works, at the northwest corner of Schuylkill-Second (Twenty-first) and Chestnut Streets, were obtained from the city, where the necessary glazing and enameling kilns, mills, etc., were erected. His first attempts were fraught with many difficulties. While the body and glaze of the earlier productions were good, the workmanship and decoration were inferior. The decoration consisted generally of landscapes painted roughly in sepia or brown.

In 1828 Thomas Hulme was admitted to the business, but retired in about one year. During this period great improvement was made in decoration, the best productions being painted with floral designs in natural colors. A number of pitchers made during that period are marked "Tucker & Hulme, China Manufacturers, Philadelphia, 1828," the only pieces from this factory known to have been signed.

Fig. 6.—Tucker Creamer. Sepia decoration.

Fig. 7.—Hemphill Vase. (Collection of Hon. James T. Mitchell.)

William Ellis Tucker died in August, 1832, but previous to this Judge Joseph Hemphill had put some money in the enterprise, and continued to carry on the business after his partner's death.

Messrs. Tucker & Hemphill purchased the property at the southwest corner of Schuylkill-Sixth (now Seventeenth) and Chestnut Streets, where they erected store-houses and three kilns, and greatly increased the producing capacity of the factory. In 1832 they appealed to Congress for the passage of a tariff law which would afford them protection from foreign competition.

Mr. Thomas Tucker superintended the business after the decease of his brother, which was carried on in the name of Judge Hemphill for about three years, but in 1835 the latter entered

into negotiations with a company of Eastern gentlemen, and sold the factory to them shortly after. In 1837 the factory was leased to Thomas Tucker, who continued the manufacture of fine porcelain for about one year, when it was permanently closed. Under the direction of Judge Hemphill, who had become interested in the subject while abroad, great improvements were made in the body of the ware as well as in the glazing and ornamentation. French porcelain was selected as the model after which the Tucker & Hemphill china was patterned, and skilled artists were brought from France to decorate the ware. Pitchers and vases were sometimes decorated with painted portraits of Revolutionary heroes; two of the former, with likenesses of Washington and Wayne, are still preserved. The later productions of this factory were greatly superior to anything produced in the United States before. They were characterized by smoothness of paste, beauty of coloring, and richness of gilding—indeed, it is said that the amount of gold consumed in the decoration of this ware was so great as to cause a considerable pecuniary loss to Judge Hemphill. It is a matter of regret that the limit of this article is not sufficiently elastic to permit a more extended review of this interesting factory and description of some of its many beautiful productions which have been recently brought to light.

FIG. 8.—HEMPHILL VASE (with painting of a shipwreck).

Isaac Spiegel, one of Tucker & Hemphill's workmen, started in business for himself in Kensington, Philadelphia, about 1837. He made Rockingham black and red ware of excellent quality, including mantel ornaments, such as figures of dogs and lions. Some of the machinery was moved to his pottery from the Hemphill factory on its closing, and he secured many of the molds which had been used for making ornamental porcelain pieces. In 1855 Mr. Spiegel retired from active business, and was succeeded by his son Isaac, who carried on the works until 1879. In 1880, John Spiegel, a brother of the latter, resumed the business, and is at

the present time engaged in burning magnesia for the drug trade.

About the time that Tucker first placed his new ware on the market a factory for the production of a somewhat similar commodity was erected at Jersey City, presumably by Frenchmen. Later, under the title of the American Pottery Company, cream-colored, white, Parian, and porcelain wares were made here. In 1842 an exhibit of embossed tea-ware, jugs, and spittoons was made by this company at the Franklin Institute, the specimens of Parian with blue ground and raised ornamentation in white being especially praiseworthy. After several changes in proprietorship the business passed into the hands of Messrs. Rouse & Turner in 1870, and the name of the factory was altered to the Jersey City Pottery. Mr. John Owen Rouse came from the Royal Derby Works about forty years ago. Mr. Turner died in 1884, leaving the former sole proprietor. The plant at present consists of four kilns, one of which has an interior diameter of nineteen and a half feet, and numerous large buildings for manufacturing and storage purposes. Here are now made large quantities of white granite ware in table and toilet services and decorative designs, a specialty of the factory being porous cups for telegraphic uses, of which fully five thousand are produced every week.

After the year 1840 the number of potteries in the United States multiplied rapidly. About that time Samuel Sturgis was making, in Lancaster County, Pa., in addition to earthen and stone ware, clay tobacco-pipe bowls, which he molded after the French designs in the form of human heads. These were glazed in yellow, green, and brown, and supplied largely to the tobacconists of eastern Pennsylvania. In 1843 there were one hundred and eighty-two potteries in that State alone, few of them, however, of any importance, whose aggregate productions amounted to $158,000. In 1890 there were only about eighty potteries in the same State, a falling off of more than half. This diminution in number does not by any means indicate a decadence of this industry, because the establishments of half a century ago were mostly scattered through the rural districts and were insignificant affairs, producing only the coarser and cheaper grades of crockery. Such potteries have almost entirely disappeared, while those of to-day manufacture, for the most part, the finer qualities of earthen, white granite, and porcelain wares. At the present time there are over five hundred potteries in the United States, not including architectural terra-cotta and tile works, of which some twenty-five are in Trenton, N. J., and about the same number in East Liverpool, Ohio.

An exhibit of Rockingham was made at the Franklin Institute in 1846 by Bennett & Brother, of Pittsburg, which was

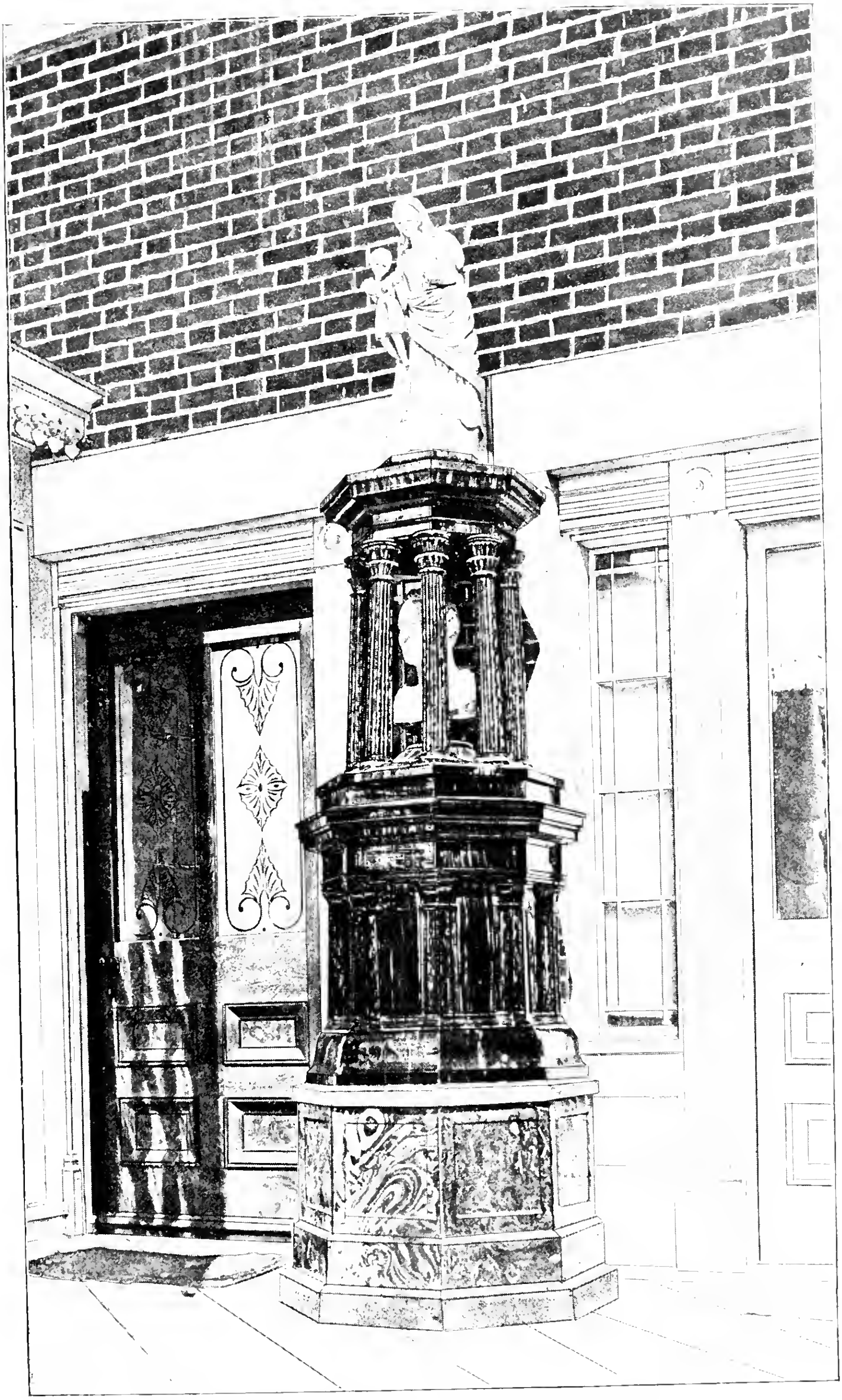


FIG. 9.—ROCKINGHAM MONUMENT. Made at Bennington, Vt., 1851.

pronounced by the judges superior to the English ware. A "tortoise-shell" pitcher, eight-sided, with human head molded in relief under the mouth, which is still in the cabinet of the Institute, was awarded a silver medal.

Messrs. Alanson Potter Lyman and Christopher Weber Fenton embarked in the manufacture of yellow and Rockingham ware in Bennington, Vt., about 1847. Three years later they commenced making white ware. Their workshop was known as the United States Pottery. In 1851, or the year following, Mr. Fenton had a large monumental piece of Rockingham made, ten feet in height, in which was placed a life-sized Parian bust of himself surrounded by eight glazed columns, the work being surmounted by figures of a woman and child in Parian. This was modeled by Daniel Greatbach, formerly connected with the Jersey City Pottery. The base of the monument is made of several varieties of clay mixed together, having the appearance of unpolished marble. It stands at present on the porch of Mr. Fenton's former residence in Bennington, having been first placed on exhibition at the New York Crystal Palace in 1853, with other productions of this factory, including a group of "patent flint enameled ware," which was probably analogous to the so-called majolica of the present day. Common china, white granite, and Parian were made here extensively. A limited amount of soft porcelain was produced also, but chiefly in small ornamental figures and statuettes. These, like the Parian pieces, were often copied from old English works. A graceful pitcher of the latter ware, in the collection of the writer, is molded with white figures in relief on a dark-blue "pitted" ground, and is almost an exact, though enlarged, reproduction of a sirup-jug from the Dale Hall Works, England. The jasper-ware of Josiah Wedgwood was also imitated in Parian. The art of the American potter had not yet reached that point where competition and public demand stimulated originality in body, design, or decoration. Fig. 10 shows a group of pieces made at the Bennington factory between 1850 and 1855. In the center may be seen a large Rockingham figure, beneath which are two small mantel ornaments of artificial porcelain. The central pitcher above the dog and the two small pitchers to the right are white granite, decorated in gold. The three remaining pitchers and the small vase are Parian, with ornamentation in relief.

The United States Pottery was closed in 1857, and two years later Mr. Fenton, with Mr. Decius W. Clark, his former superintendent, went to Peoria, Ill., and there established a manufactory of white and granite wares. After a period of three years this experiment proved a financial failure, and the factory passed into other hands. At present it is being successfully operated by the

Peoria Pottery Company, which makes a fine grade of similar goods.

Messrs. Haughwout, Dailey & Co. had a decorating establishment in New York city in 1853, and employed a hundred hands in painting French china for the American market. Mr. James Carr, who came to this country in 1844, worked for the American Pottery Company of Jersey City until 1852, when he went to South Amboy, and there established a pottery for the manufacture of

FIG. 10.—WARE MADE BY LYMAN & FENTON.

yellow and Rockingham wares. In October, 1855, he started a pottery in New York, under the firm name of Morrison & Carr, where table-services in opaque china, white granite, and majolica were made. He directed his efforts toward the attainment of higher standards, and his experiments resulted in the production of some artistic pieces of porcelain and faience, excellent both in design and execution; but as there was little demand for this class of goods at that time, these attempts were discontinued. In 1888, owing to the close competition of out-of-town manufacturers, the New York pottery was closed and the factory torn down. Mr. Carr has recently built, on the premises in West Thirteenth Street, several large stores, the rentals from which, he claims, yield him better returns than potting.

The Philadelphia City Pottery of Mr. J. E. Jeffords, who came from the New York establishment of Messrs. Morrison & Carr about 1860, includes two distinct factories, one of which turns out a high grade of Rockingham, yellow, and white-lined blue ware, while the adjoining workshop produces an excellent variety of white and decorated earthenware for toilet and table use. In Rockingham some of the old English designs are reproduced, such as the "Toby" ale-jug and the cow creamer. A few years ago a more elaborate ornamentation was attempted in the paint-

ing of bird and floral subjects above the glaze, but this was soon discontinued owing to the expense. Printing from copper plates is extensively practiced here at the present time, and competent artists are employed to apply the gold in pleasing devices to the rich dark glazes which characterize the better grades of ware produced. Mr. Jeffords has fully equipped his factories with the most approved modern appliances, and is one of the most progressive and successful of our modern potters.

Mr. Alexander William Robertson started a small pottery in Chelsea, Mass., in the year 1866, for the manufacture of brown ware such as was made in Great Britain, and of lava-ware similar to that of Germany. Two years afterward, Mr. Hugh Cornwall Robertson, a younger brother, was admitted to partnership in the business, the firm name being A. W. & H. C. Robertson, when the production of brown ware was discontinued and the manufacture of plain and fancy flower-pots was substituted. In the following year porous cones or filters of a high grade were made for chemical purposes. In 1872 James Robertson, a practical potter of wide and varied experience in Scotland, England, New Jersey, and New York, and recently from the East Boston pottery, joined his sons, the firm name being changed to James Robertson & Sons, when work of a more pretentious character was undertaken. A red bisque ware, in imitation of the antique Grecian terra-cottas and Pompeiian bronzes, was first produced in 1875. The factory adopted the name of the Chelsea Keramic Art Works. The red ware was characterized by a remarkably fine texture and smooth finish, the clay being peculiarly adapted to the faithful reproduction of the graceful classic forms, the fine polished grain offering an excellent surface for the most minute carving, showing the engraved lines as perfectly as on wood. In 1876 a pleasing effect was obtained by polishing the red ware with boiled linseed oil. On a few spherical vases thus treated, Mr. F. X. Dengler, the talented young sculptor who afterward died at the age of twenty-five, modeled from life, in high relief, choosing child and bird forms. The firm also received the benefit of advice from a number of capable artists, including, John G. Low, G. W. Fenitz, and others. For lack of public support this branch of the art was abandoned. The next venture was the Chelsea faience, introduced in 1877, which is characterized by a beautiful soft glaze. This ware soon attracted the attention of connoisseurs, and carried the firm to the front rank of American potters. The decoration consists of floral designs, either made separately by hand and sprigged on, or carved in relief from clay laid directly on the surface while moist. Some beautiful effects were produced by hammering the surface of the faience before burning, and afterward carving sprays of flowers in relief in clay applied to the

surface. This modeling was executed by Miss Josephine Day, a sister-in-law and pupil of Mr. H. C. Robertson, and by Mr. Robertson himself. Being done by hand from original designs, no duplicates were produced. On some of the hammered vases the designs were cut into the surface and filled in with white clay, forming a mosaic, the bases of the vessels being colored buff, which offered a pleasing contrast through a semi-transparent

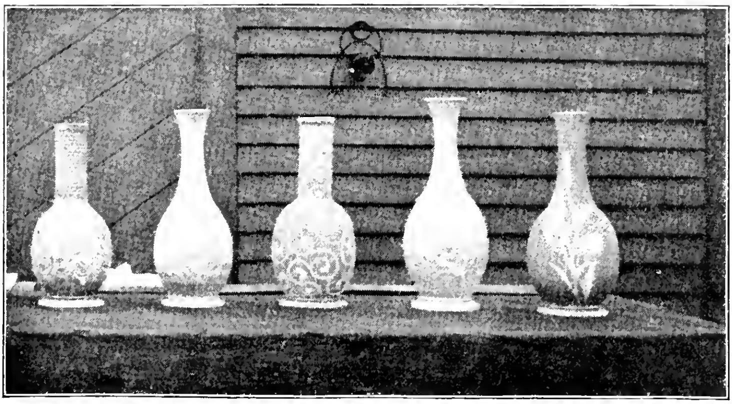


Fig. 11.—Inlaid, Hammered and Embossed Pottery. (Chelsea Keramic Art Works.)

glaze. About the same time a variety of faience known as the Bourg-la-Reine of Chelsea was produced, after the discovery of the process of painting on the surface of the vessel with colored clays and covering with a transparent glaze, on the principle of the Limoges faience.

Mr. James Robertson died in 1880, after a long and useful life, at the ripe age of seventy years. The firm continued under the same name, and in 1884 A. W. Robertson retired from the business. In that year the remaining partner, Mr. Hugh C. Robertson, discovered a stone-ware somewhat resembling Parian in appearance, possessing a hard, vitrified body, which he worked into a variety of artistic forms.

From this time Mr. Robertson directed his efforts toward solving the secret of the famous Chinese *Sang de bœuf*, and after four years of sacrifice and patient investigation his labors were crowned with success. This discovery is the exact treatment necessary to produce the true ox-blood red, which with the Chinese was the result of accident rather than an established art. The body is the true stone, perfectly water-proof, and capable of resisting as high a degree of heat as any known ware. The forms of the vases are simple, with curving outlines, and entirely devoid of ornamentation which would tend to impair the beauty of color, which is that of fresh arterial blood, possessing a golden

lustre, which in the light glistens with all the gorgeous hues of a sunset sky. In experimenting to obtain the blood-red of the *Sang de bœuf*, varieties were produced of a deep sea-green, "peach-blow," apple-green, mustard-yellow, greenish blue, maroon, and rich purple. Specimens of this ware have been secured by a number of prominent collectors throughout the United States, but the demand for works of this character being limited, the remaining examples which were produced still rest on the dusty shelves in the Chelsea workshop. The history of the discovery of this process is a repetition of the old story of genius.

Fig. 12.—Plaque representing Spring. (Designed by H. C. Robertson, 1879.)

After twenty-four years of devotion to art, Mr. Robertson finds himself unable to prosecute the work further, and for over two years the fires have not been lighted in his kilns. It is difficult to explain the apparent indifference of Americans to works of artistic merit which emanate from their countrymen.*

* Since writing the above, word comes to us that a company has been incorporated under the name Chelsea Pottery U. S., and date July 17, 1891, of which Mr. Hugh C. Robertson will be the manager.

Thus far we have attempted to review, in the briefest manner, some of the earlier potteries in the United States. The space at command has only permitted the bare statement of facts relating to the condition of the ceramic industry down to the period just preceding the Centennial Exposition of 1876. It has not been possible to refer to many establishments whose record would be necessary to a full history of the development of this art. Let us now see what progress has been made in the methods employed in this country down to the present time.

The potter's wheel used well into the present century was a clumsy and primitive affair. It consisted of a perpendicular beam, generally about two feet in height, surmounted by a circular disk a foot or so in diameter. At the lower extremity of the beam or axis was a horizontal wooden wheel, four feet across, possessing four inclined iron spokes which extended from the beam to the rim of the wheel, which the workman pushed around with his feet. He sat on a framework behind the wheel, while in front were piled the lumps of clay to be manipulated.

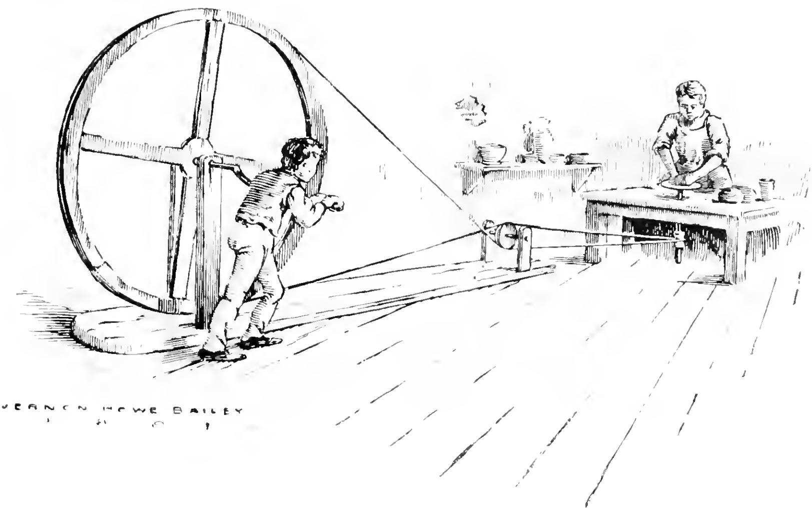


FIG. 13.—OLD-FASHIONED "THROWING WHEEL."

A great advance was made in potters' machinery a few years later, or in the first quarter of the present century, when the "throwing wheel" was introduced into the more prominent factories. This was composed of a plate or disk which was revolved by means of a belt which passed around two spindles and extended to a large vertical wheel operated by a crank in the hands of a second person. This upright wheel usually measured four, five, or more feet in diameter, depending on the rate of velocity desired; the larger the wheel, the greater the speed to be attained.

The revolving plate at which the potter sat was often ten or more feet from the crank-wheel, and the apparatus was therefore cumbersome, besides requiring the services of an extra hand. This contrivance was a great improvement over the old method of turning, as it secured uniformity of motion and enabled the operator to devote his entire attention to his work. This style of wheel, in time, was superseded by the more simple form which is worked by a treadle with the left foot of the operator, and is still used in many of the smaller potteries. The subjoined engraving

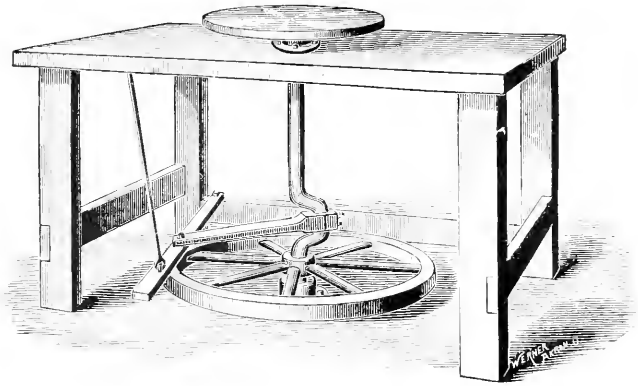


Fig. 14.—"Kick Wheel (now used).

represents one of these "kick" wheels, as made at the present time by Messrs. Taplin, Rice & Co., of Akron, Ohio. This firm also manufactures a power-wheel such as is now operated in the larger factories, which is so constructed that the velocity can be regulated by a foot-lever.

The old methods of grinding and mixing clays by hand have given place to improved mechanical processes. In olden times it was customary for one or two men to manipulate the clay, which was placed in a square tank sunk in the floor, with a wooden shovel or paddle. Now this work is performed much more effectively and rapidly by special machinery known as "blungers," "pug" and "grog" mills, etc. Some of the improved grinding mills have a capacity of twenty-five tons or more per day, and the agitating and mixing machines perform the work of many men.

I have in my possession a drawing of the old-fashioned slip kiln used by Messrs. Tucker & Hemphill in 1832. This consisted of a long horizontal brick fire-box, at one end of which were built three partitions or pans, one after the other. In these the slip was poured, and flues passing around the sides furnished the heat necessary to dry the clay to the proper consistency. This drying process was necessarily a slow one. The contents of the pan nearest the fire-box would be ready for removal first, and

the others in succession. A recent invention has simplified this process very materially. This device is a clay press consisting of a series of sacks in which the slip is placed. The moisture is forced through the bags by strong pressure, and the clay is ready for use. Mr. A. J. Boyce, of East Liverpool, Ohio, has recently perfected an improved hydrostatic press, which is being introduced into many of the more progressive factories throughout the country. The illustration will convey a clear idea of the clay

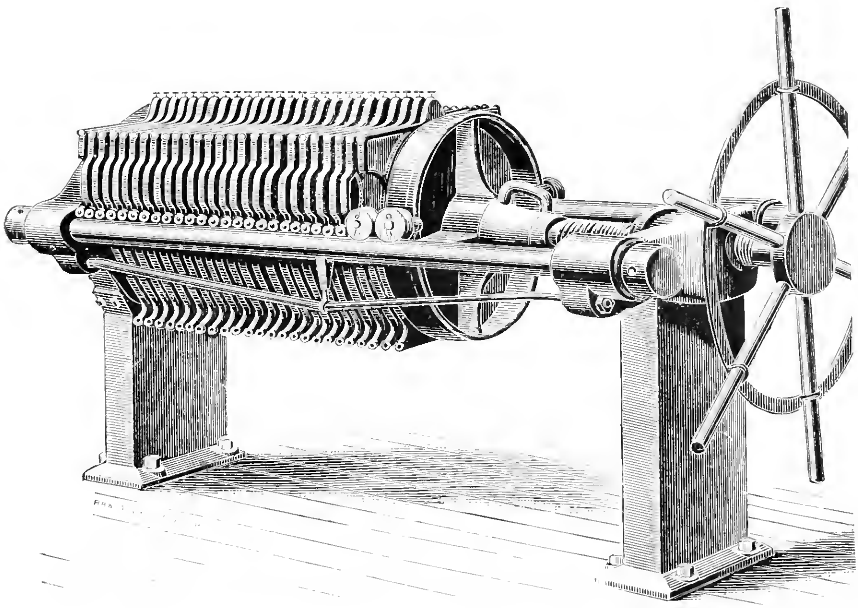


Fig. 15.—The Boyce Clay Press, with twenty-four Chambers.

press used in reducing the slip to a workable mass. In each chamber is placed a sack made of ten-ounce Woodberry duck, which, if of the proper quality, will last some time. The moisture is pressed through the fabric, and the clay, on removal, is ready for manipulation.

"Jiggers" and "jollies" now greatly facilitate the manufacture of circular and swelled vessels, such as jars, jugs, crocks, cuspidors, and umbrella jars. A "jigger" is a machine which carries a revolving mold, in which the clay is shaped by a former, which is brought down into the mold and held in place by means of a lever. We give here an illustration of one of the jiggers made by Mr. Peter Wilkes, of Trenton, N. J. *A* is the jigger-head or receptacle in which the mold is placed, which is screwed fast to the revolving spindle. *B* is a stationary iron column on which the frame or sleeve *C* slides up or down. *D* is an iron fork

which prevents the frame *C* from turning. *E* is the former or profile which shapes the interior of the vessel. The lever or pull-down, above the horizontal bar *F*, gives a transverse motion, and forces the former toward the side of the mold. 1 and 2 are adjustable collars which are fastened by screws: 1 regulates the distance to which the collar or frame *C* must be lowered to give the proper thickness to the bottom of the vessel, while 2 acts as a stop to prevent the frame from being thrown up too high.

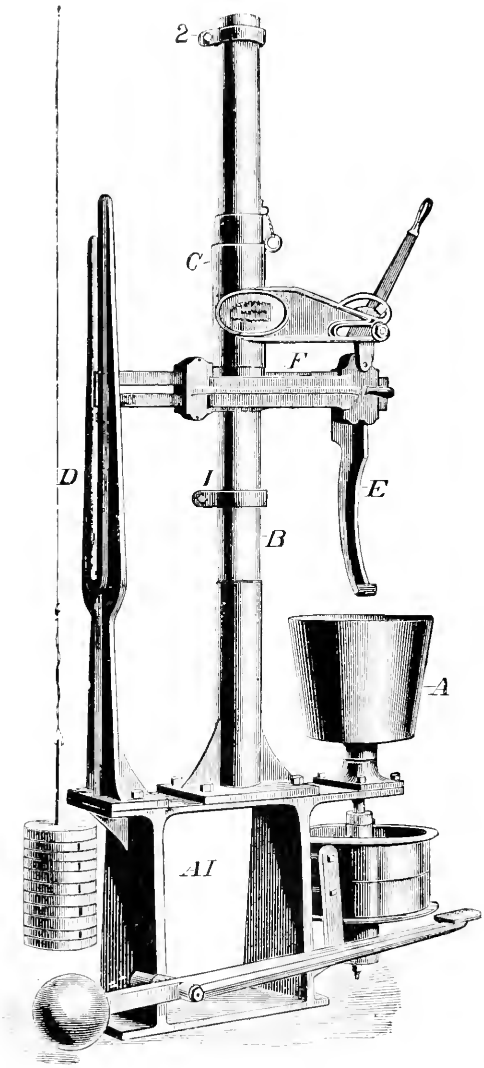


Fig. 16.—"Jigger."

A "jolly" is a somewhat similar contrivance, consisting of a table on which is a revolving mold with a single or double pull-down.

The construction of pottery kilns has changed but little in the past fifty years. The glaze kiln of the Tucker & Hemphill factory was made on the French plan. It possessed six fire-boxes and the same number of flues, eight inches in width, which passed through solid walls and met in the center. Besides the central space there were two circular passages, one extending around the circumference of the kiln and another midway between this and the center. Modern kilns are generally made about fifteen to sixteen and a half feet diameter inside, and measure about the same in height to the crown, with usually ten fire-boxes. In some of the Western kilns slight modifications have been made in the latter for the employment of natural gas, which is used instead of coal.

Until quite recently each establishment made its own saggers or fire-clay boxes in which the ware is burned, but now they are made in large numbers by machinery and supplied to the trade by the Trenton Terra-Cotta Company at a very low price. In the manufacture of earthenware formerly, "cockspurs" were used to separate the pieces when placed in the kiln. These were small four-pointed objects of clay formed somewhat like the old-fashioned caltrop, three of the arms resting on the lower vessel while the upper supported another above. Three spurs being used, it is evident that the upper surface of the lower piece would show nine marks after coming out of the kiln, where the points tore away the glaze, as in old Delft plates. The bottom of the upper vessel would show three. "Cockspurs" and "cones" were superseded by "pins" and by "triangles" and "stilts," having three horizontal arms, equidistant, with double points projecting upward and downward. These were for some time made by hand at the factories where they were to be used, but recently they have been made in assorted sizes by machinery, and sold to potters more cheaply than they could be made by hand.

Labor-saving machines have greatly simplified the work of the potter. Steam power has to a great extent taken the place of hand and foot power in running wheels, lathes, "jiggers," and "jollies." Steam grinding-mills, "blungers," sifters, and clay-presses now grind, sift, mix, dry, and prepare the clay for the workman. There are many other problems to be solved, however, in order to still further cheapen the production of utilitarian articles. The committee appointed by the United States Potters' Association to investigate the subject of potters' machinery, in their report presented at the convention held in 1890, used the following language: "We think we can see in the distance a cloud no bigger than a man's hand, which we trust will speedily increase to such proportions that the industry will feel the outpouring of benefits such as have not entered into the imagination of the potter's mind. We require only to get the

FIG. 17.—SLIP-DECORATED PIE DISH. ALLENTOWN, PA., 1826.

American mechanical mind turned in the direction of our need, and we will not fear for the future of our business.

"We would urge upon the manufacturing potters that more thought be given to this subject, and that they come in closer touch with the best machinists of our several centers. Let the practical machinist know our need. Much can be done; much must be done if we expect to hold our own. And what is our own? The American market for American manufacturers."

Note.—Several of the illustrations which appear in this paper are from pen-and-ink drawings made from the original porcelains by Mr. Vernon Howe Bailey, a student at the Pennsylvania School of Industrial Art, Philadelphia.

[*To be continued.*]

PROGRESS AND PERFECTIBILITY IN THE LOWER ANIMALS.

By Prof. E. P. EVANS.

WHAT we call institutions are only organized and hereditary instincts, and are common to man and the lower animals. The original social character of animals, which forms the basis of their institutions, is also the quality that renders them capable of domestication. Man simply takes advantage of this quality, and turns it to his own account by bringing the animal into his own domestic circle and service and making it a member of his household.

In birds, for example, the conjugal instinct is remarkably strong, or, as we would say in speaking of human relations, the institution of marriage, either in its monogamous or polygamous form, is firmly established and highly developed, and forms the foundation of a well-ordered domestic and social life.

The paternal fox trains his young with as much care and conscientiousness as any human father; the beaver constructs his habitation with the foresight of a military engineer and the skill of an experienced architect; the bee lives in well-regulated communities, forms states, and founds colonies; and the ant not only cultivates the soil, plants crops, gathers in the fruits of his labor and stores them for future use, and keeps other insects as domestic cattle, but shares also the vicious propensities and domineering disposition of man, waging war on creatures of his own species and holding his prisoners as slaves.

These habits or customs have the same origin and character in the lower animals as in man, being in both cases products of evolution and undergoing modifications from generation to generation. Animal, not less than human, societies are governed by

their laws and traditions, and preserve a sort of historical continuity by which past and present are bound together in a certain orderly sequence. Bee-hives which suffer from over-population rear a queen and send forth with her a swarm of emigrants to colonize, and the relations of the mother-hive to her colonies are known to be much closer and more cordial than those which she sustains to apian communities with which she has no genetic connection. Here the ties of kinship are as strong and clearly recognized as they are between consanguineous tribes of men.

Again, the statement that animal habits are fixed, and human customs variable and improvable, is true only to a very limited extent. Closer observation has shown the latter to be more stable and the former more mutable than is generally imagined, especially if we compare the highest orders of animals with the lowest human tribes. In primitive society and among savage races customs remain the same for countless generations, and seem to be quite as persistent and incapable of change as animal instincts.

Not only do animals, often in the course of a comparatively short period, undergo marvelous transformations both of mind and body, through the force of natural selection or by careful interbreeding, but they are also led by circumstances and through forethought to make conscious and intentional changes in their manner of life.

It is curious to note the variety of characteristics distinguishing members of the same family or genus. Thus, the European cuckoo lays her eggs in the nests of other birds, and leads the life of a shiftless parasite and shameless polyandrous vagabond. The American cuckoo, on the contrary, has not yet learned to shirk her maternal duties and domestic responsibilities, but, like an honest and thrifty housewife and conscientious mother, hatches her own eggs and rears her own young. The South African and Australasian representatives of the *cuculinæ* follow, in this respect, the habits of the European bird. There is also a species of *molothrus*, which sometimes begins but seldom finishes a nest, like the hypothetical man in the parable, who would fain build without first sitting down to count the cost. She is seized occasionally with a spasm of virtuous endeavor in this direction, but soon yields to the greater comfort and convenience of imposing upon others the burden of brooding and nurturing her offspring. Evidently she turns the matter over in her mind, and, like Rousseau, reasons herself into the belief that it is better not to assume any family cares, but to cast her children as foundlings upon the bosom of public charity. "There are the goldfinches, thrushes, fly-catchers, cardinal grossbeaks, and other fussy motherly fowl," she seems to say, "willing enough to undertake the charge; why not gratify their low philoprogenitive passion, and thus enable me to devote

myself to more congenial pursuits!" Still another kind of *molothrus* leads the life of a squatter, never building a nest of her own, but brooding in the abandoned nest of some other bird.

Many birds have, within the memory of man, made considerable advances in architectural skill, and adopted new and improved methods of constructing their nests. This progress has been observed especially in California since the settlement of that country, and in all cases the young profit from the knowledge acquired by their parents, and the improvement becomes a permanent possession of the race. In places where they are particularly exposed to the attacks of pugnacious sparrows, they have been known to close the opening in front of their nests and make the entrance on the back near the wall. In some instances this purely precautionary and defensive change of structure, after its efficiency had been tested in a single nest, has been adopted by the swallows of an entire district. Orioles, according to the observations of Dr. Abbott, finding that the bough from which they have suspended their nest is too slight to sustain the weight of the full brood, attach it by a long string to the branch above, fastening it securely "by a number of turns and a knot." It would be difficult to say in what respect the mental process leading to the adoption of such a mechanical contrivance differs from that which causes an architect to buttress a weak wall.

The Baltimore oriole also adapts the texture and structure of its nest to the exigencies of climate. In the Southern States it selects a site on the north side of a tree, and builds of Spanish moss loosely put together and without lining, so as to permit a free circulation of air. Farther north it seeks a sunny exposure, builds more compactly, and uses some soft material for lining. The impulse to build is instinctive, but conscious intelligence is exercised in modifying the methods of building to suit circumstances.

The same bird now uses yarn and worsted instead of vegetable fiber for its nest, but it always selects for this purpose the least conspicuous colors, such as gray and drab; and yet the bird's gorgeous plumage is proof, according to the theory of sexual attraction, that bright colors are pleasing to it. Here we have an example of æsthetic pleasure being subordinated to considerations of safety; the prudent oriole, notwithstanding its fondness for resplendent hues, choosing those colors which render its nest less visible and more difficult to discover, and rejecting those which, in other respects, are more gratifying to its fancy.

The tailor-bird of East India used to stitch the leaves of its nest together with fine grass, horse-hair, and threads, which it twisted out of wool; since the introduction of British manufactures it uses sewing-thread and the filaments of textile fabrics,

except in remote regions, where the ingenious bird still works on in the primitive way. So, too, in America, birds in constructing their nests everywhere turn to their account the products of human industry and keep abreast with the progress of the age. The materials employed correspond to the contemporary state of civilization, and mark the periods of industrial development through which the human race has passed. The wagtails, in a watch-making district of Switzerland, have learned to build their nests of fine steel shavings; a nest of this kind, if preserved, would indicate to the inhabitants of that country a thousand years hence the kind of industry that was carried on by their ancestors. Sparrows, which usually build in chinks of walls or under roofs, if forced to build their nests in trees or other unsheltered places, cover them with a sort of hood to keep out the rain. Buffon, who records this fact, adds: *L'instinct se manifest donc ici par un sentiment presque raisonné et qui suppose au moins la comparaison de deux petites idées.* In the presence of such clear manifestations of thought and reflection, it seems absurd to speak of a "sentiment almost reasoned," or to indulge in condescending baby-talk about "two little ideas."

Apiarists now provide their hives with artificial comb for the storage of honey, and the bees seem glad to be relieved of the labor of making cells as their predecessors had done. Instead of gathering propolis from the buds of plants, the workers stop their hives with the mixture of resin and turpentine with which the arboriculturist salves wounded trees, and readily substitute oatmeal for pollen if they can get it. These facts, and many others which might be adduced, suffice to prove that animals avail themselves of new discoveries and easier methods in order to increase the comforts and conveniences of life.

Even instincts, which seem firmly rooted and are regarded as characteristic of the class, are by no means so persistent as is commonly supposed. The individual inherits, but soon loses them if they are not brought into early exercise. A duck or gosling, if reared in the house until it is two or three months old, has no greater liking for the water than a chicken, and if thrown into a pond will scramble out, showing signs of great fear of the element to which its web-feet are particularly adapted. An artificially hatched chicken does not attach itself to a hen more than to any other animal, but follows its first associate, a child, a cat, or a dog.

Buffon denies that animals are susceptible of what he calls "the perfectibility of the species." "They are to-day," he says, "what they always have been, and always will be, and nothing more; because, as their education is purely individual, they can only transmit to their young what they themselves have received

from their parents. Man, on the other hand, inherits the culture of ages and gathers and conserves the wisdom of successive generations, and may thus profit by every advance of the race, and, in turn, aid in perfecting it more and more."

This assertion has been repeated by scientists of the old school as though it were an axiom of natural history, instead of an arrogant anthropocentric assumption refuted by scores of well-authenticated facts. The whole process of domestication, which is to the lower animals what civilization is to man, and the possibility of producing and propagating desirable qualities in the race, run counter to Buffon's theory. The value of a horse's pedigree depends upon the transmissibility of distinctive characteristics which were originally peculiar to some individual horse, idiosyncrasies which commended themselves to man as worthy of preservation, or such as in the natural struggle for existence would assert and propagate themselves.

If the descendants of blood-horses do not inherit the individual training of their sires, neither are the children of scholars or musicians born with a knowledge of books or the ability to play on musical instruments. What is inherited in both cases is some particular disposition or endowment, a superior aptitude for the things in which their progenitors excelled. Indeed, this heritage is handed down in horses with surer and steadier increase, or, at least, with smaller loss and depreciation than in human beings, since they are mated with sole reference to this result; and there is no room left for the play of personal fancy and caprice, or for social, sentimental, or pecuniary considerations, which exert a baneful influence upon marriage from a physiological point of view, and contribute to the deterioration of the race. This is strikingly perceptible in some portions of Europe, where the struggle for existence, and especially for high social position, is exceedingly intense, and a large dower suffices to cover up all mental and physical deficiencies in the bride.

The scientific swine-breeder keeps genealogical tables of his pigs, and is as jealous of any taint in a pure porcine strain as any prince of the blood is of plebeian contamination. In both cases the vitiation bars succession, the one condition of which is purity of lineage. It is by the selection not only of the finest stock, but also of the choicest individuals for breeding, that animals are "progressively improved" both bodily and intellectually. This is, perhaps, most clearly observable in hunting-dogs and race-horses, which have undergone quite remarkable modifications within the present century owing to the extraordinary pains taken to develop and perfect their peculiar characteristics. In some instances unusual births or freaks of nature are preserved, and by persistently propagating themselves form the starting-

point of new species. A striking example of this perpetuation of individual peculiarities is the short-legged and long-backed Ancon sheep, a comparatively recent product of Nature rendered permanent by the care of man. A pointer, greyhound, or collie inherits and transmits to its offspring not only race attributes, but also acquired aptitudes in the same manner and to the same degree as a human being does who is distinguished for some special faculty. There are prodigies of dogs which do not beget prodigies of puppies, just as there are men of genius whose children are by no means eminent for their intellectual endowments.

If the conceptual world of the lower animals is limited and fragmentary, so is that of savages and of ignorant and uncultivated men, who live for the most part in the present and the immediate past, and have a relatively narrow range of thoughts and experiences. Long-lived animals, such as parrots, ravens, and elephants, have an advantage over short-lived animals in the development of intelligence. Civilized man, however, not only lives his own individual life, and profits, like other animals, from the wisdom of his parents and the influences of his environment, but also, by means of written records, lives the life of the race, of which he enjoys the selectest fruits garnered in history.

It must also be borne in mind that dogs are and always have been bred for special purposes, such as pointing, retrieving, running, watching, and biting, but not for general intelligence. Mr. Galton, who calls attention to this fact, suggests that it would be interesting as a psychological experiment to mate the cleverest dogs generation after generation, breeding and educating them solely for intellectual power and disregarding every other consideration.

In order to carry out this plan to perfection and to realize all the possibilities involved in such a comprehensive scheme, it would be necessary to devise some system of signs by which dogs would be able to communicate their ideas more fully and more clearly than they can do at present, both to each other and to man. That the invention of such a language is not impossible is evident from what has been already achieved in the training of dogs for exhibition, as well as from the extent to which they have learned to understand human speech by mere association with man. Prof. A. Graham Bell believes that they may be taught to pronounce words, and is now making scientific experiments in this direction. The same opinion was expressed two centuries ago by no less an authority than Leibnitz, who adduces some startling facts in support of it. The value of such a language as a means of enlarging the animal's sphere of thought and power of conception, and of giving a higher development to its intellectual faculties, is incalculable.

Every dog trained as a hunter or herder is a specialist, and is prized for one fine capacity attained in some degree at the expense of mental proportion and symmetry; in miscellaneous matters outside of his province he may be easily surpassed by any underbred and mongrel but many-sided village cur. Modern scholarship shows a like tendency to psychical alogotrophy or one-sided intellectual growth. As science deepens its researches, each department of investigation becomes more distinct, and the toiler in the mines of knowledge is forced to confine his labors to a single lode if he would exhaust the treasures it contains. He sees clearly so far as his lantern casts its rays; but all outside of this small luminous circle is dense darkness.

If a race of superior beings had taken charge of man's education for thousands of years and conducted it on the same principle as that which has guided us in domesticating and utilizing the lower animals, what maimed specimens of humanity would have been the result! Slavery has always tended to produce this effect; but the slave, however degraded his condition, speaks the same language as his master, thereby profiting from his intercourse with those who are placed over him, and sharing in the general progress of society more fully than any dumb animal could do. So, too, the position which Christian intolerance assigned to the Jews for many centuries, closing to them all branches of industry except usury, developed in them a peculiar talent for finance, together with many hard and offensive traits of character naturally growing out of money brokerage, and finally becoming almost innate. In the middle ages they were made to serve as sponges to suck up the people's substance in order that it might be squeezed out of them at the convenience of the rulers. King John II, surnamed the Good, issued in 1360 a decree permitting the Jews in his realm to take, as compensation for loaning money, "quatre deniers par livre par semaine," equivalent to ninety per cent per annum, not from any feeling of favoritism for the Israelites, but, as he expressly stated, because "the greater the privileges enjoyed by the Jews, the better they will be able to pay the taxes levied on them by the king." This "good" monarch was wont to confiscate periodically a large portion of the pillage thus obtained in order to replenish his exhausted exchequer, and was actually praised by his subjects for punishing Jewish rapacity. It was a system of indirect taxation worthy of modern tariff legislators.

In the early part of the thirteenth century, Frederic II, the Hohenstaufen, ordained that the Jews should be permitted to dwell in Nuremberg and to lend money on interest, stating that, "inasmuch as this sinful business is essential to trade and to the commercial prosperity of the city, it would be a lesser evil to let the

Jews carry it on than that Christians should imperil the salvation of their souls by such practices, since the former, owing to their notorious obduracy, will doubtless persist in their religious perversity and be damned anyhow." If the Jews now "take a breed of barren metal" as naturally as a pointer takes to pointing or a hound to the trail of a fox, this tendency is due in part at least to circumstances which they did not create and could not control. The chief accusation brought against them by anti-Semitic agitators is that they are unwilling to follow industrial or agricultural pursuits, in utter forgetfulness of the fact that until a comparatively recent date they were forbidden by Christian legislation either to engage in mechanical employments or to own land.

The influence of domestication on the mental development of animals depends upon the purposes which the domesticator has in view. If he regards them merely as forms of food, and his sole aim is to increase the amount of their adipose tissue and edible substance and thus get the maximum of meat out of them, then domestication tends to stupefy them. The intellectual training of the pig would naturally diminish the quantity of lard it would produce. So far as man is concerned, this latter function is the chief end of the porker's existence, and it must not be *tried* and found wanting in this respect, whatever may be its mental deficiencies. It must be fat-bodied whether it be fat-witted or not, and the natural qualities which do not contribute to its gross weight and enhance its ultimate value as victuals are systematically discouraged and depressed.

In view of the treatment that the pig has received for centuries at the hands of man, it is remarkable that the animal has retained so much of its original cunning and love of cleanliness as it now possesses. That a creature so fond of bathing in pure running water should be condemned to a filthy sty is an act of unconscious cruelty discreditable to human discernment. If the sow that has been washed returns to her wallowing in the mire, it is as a last resort in hot weather; she would much prefer a clear pond or limpid stream if she could get access to it.

Being fed and protected by its owner in its domestic state, the hog no longer needs to exercise the faculties which were essential to the self-preservation of its wild progenitors. The stimulus arising from the struggle for existence ceases, and, as it is reared solely to be eaten, its association with man does not call forth any new powers. In China and Polynesia, where the dog is esteemed chiefly as food, it is a sluggish and stupid beast. On the other hand, the pig can be trained to hunt, and not only acquires great fondness for the sport, but also shows extraordinary sagacity in the pursuit of game. It has an uncommonly keen scent, and can be taught to point better than the pointer.

Curiously enough, when the pig is used for hunting purposes, the dogs, usually so eager for the chase, sullenly retire from the field and refuse to associate with their bristly competitor in venery. Possibly the hereditary and ineradicable enmity between the dog and hog as domestic animals may be a survival of the fierce antipathy which is known to exist between the wolf and the wild boar. In Burmah the ringed snake is trained for the chase, and is especially serviceable in flushing jungle-cock, since the reptile can penetrate the thickest underbrush, where it would be impossible for a dog or a falcon to go.

The tamability of an animal is simply its capability of adapting itself to new relations in life, and depends partly on its mental endowments, but still more upon its moral character. It is quite as much a matter of temperament and social disposition as of quickness of understanding. The elephant, dog, and horse among quadrupeds, the beaver among rodents, and the daw and raven among birds, are, for this reason, most easily tamed, and show the most marked and rapid improvement in consequence of their daily intercourse with man. Intellectual acuteness without the social affections and kindred moral qualities rather resists than facilitates domestication. Of all domestic animals the cat was the most difficult to tame, and it needed the patience and persistence so strongly characteristic of the ancient Egyptians, sustained by religious superstition, in order to accomplish this result. Even now the cat, although extremely fond of its home and capable of considerable attachment to persons, has never been reduced to strict servitude and become the valet of man like the dog, but has always remained to a certain degree what it originally was, a prowling beast of prey.

Barking in dogs is a habit due to domestication. The wild dog never barks, but only howls, like the Himalayan buansu, or merely whines, like the East Indian colsum; and the domestic dog reverts from barking to howling when it relapses into its primitive state. Wagging the tail is another mode of expression which the dog has acquired through association with man. It is well known, too, that a dog which has been reared by a cat adopts many of the habits of its foster-mother, such as cleaning itself with its paw; by continuously pairing such dogs and rearing them under like influences it would be possible to produce a canine species with feline traits, which should become permanent and transmissible.

A recent writer, Dr. Leopold Schutz, professor in the theological seminary at Treves, who may be taken as an extreme representative of the old orthodox school of zoöpsychologists, maintains that animals do not think, reflect, form purposes, or act with premeditation of any kind, have no freedom, no choice,

no emotional or intellectual life of their own, but that a higher power performs all these operations through them as cunning pieces of mechanism. The bird sings, according to this theory, without any personal pleasure or participation in its song; it sings at a certain time and can not help it, nor is it able to sing at any other time. The living cuckoo is as automatic as the wooden cuckoo of a Black Forest clock, and under the same mechanical compulsion to sing its song when the appointed hour arrives. Altum, in his book on bird-life (Der Vogel und sein Leben, Münster, 1868), infers from the fact that a bird sings more in the pairing season than at other seasons of the year, that its song is a "natural necessity," in which it takes no individual pleasure. But this conclusion by no means follows from the premises. The song is a means to an end, and has for its final object sexual attraction and selection. One would surely not be justified in inferring that a woman who dresses well, chiefly in order to gratify her husband or her lover, finds no individual æsthetic satisfaction in a fine gown; or that a man goes a-wooing from "natural necessity," and gets no entertainment out of courtship.

Prof. Schutz's doctrine that animals are mere puppets, whose movements are determined by the direct intervention of higher powers, seems to have been derived from what is recorded of the relations of these creatures to holy men in the legends of the saints, rather than from a scientific study of the book of Nature; his point of view is not that of the zoöpsychologist, but that of the hagiologist.

The chief difficulty attending the investigation of mental processes in animals is that they can not express themselves in human language and explain to us their thoughts and feelings and the motives underlying their conduct. We are thus liable to misinterpret their actions and deny them many endowments which they really possess, just as the first explorers of new countries fail to discover in savages ideas and conceptions which are afterward found to characterize them in a remarkable degree.

We have happily rid ourselves somewhat of the ethnocentric prepossessions which led the Greeks, and still lead the Chinese, to regard all other peoples as outside barbarians; but our perceptions are still obscured by anthropocentric prejudice which prevents us from fully appreciating the intelligence of the lower animals and recognizing any psychical analogy between these humble kinsmen and our exalted selves.

TYPE-CASTING MACHINES.

By P. D. ROSS.

IN the composing-room of the New York Tribune some forty type-casting machines have been used for several years. The foreman informed me in October last that all the ordinary reading-matter in the Tribune was being "set" by these inventions, and expressed himself perfectly satisfied with the working of the machines. As a rule, he said, not one of them was out of order, and on the average each did the work of three fair compositors. In a printed circular issued by the patentees of the machine, the foreman, Mr. G. W. Shafer, declares that, compared with what the same amount of setting would cost if done by hand by compositors, "the machines save the Tribune office sixty per cent—probably more."

My object in visiting New York at that time was to look into the type-casting process. The result of the visit was a conviction that the problem of setting type by machinery has been solved. Small printing establishments may not benefit from it for a few years. Large establishments, particularly large newspapers, may profit at an early date. The New York papers are looking to this. The business manager of the World, Mr. G. W. Turner, informed me that he had ordered one hundred machines. In the composing-room of the Brooklyn Standard-Union I saw six machines working. I was informed that orders for machines had been placed by the New York Sun, Herald, Times, and Mail and Express. Outside of New York, the Louisville Courier-Journal uses thirty machines, and says it saves fifty per cent of what hand composition used to cost it. The Providence Journal uses twelve machines, and claims to save two hundred and fifty dollars per week. The Chicago News says it is saving fifty per cent in the cost of composition. These are only some of the newspapers which state that they have been using the machines regularly and successfully during the past year. Four machines ordered by the Canadian Government have been used in the Government Printing Bureau at Ottawa for some months, and, in reply to a question in the House of Commons recently, the Secretary of State, Hon. J. A. Chapleau, said that they were satisfactory and economical.

All this goes to show that the type-casting principle has obtained a practical footing in the market. In discussing the subject, I propose to confine myself as much as possible to my personal experience and investigations. If I state anything which I do not know personally or have not been told at first hand by disinterested persons, I will give the source of my information.

WHAT TYPE-CASTING IS.—Before describing the type-casting principle, allow me to review briefly the process of type-setting by hand.

In this process the operator, technically called a "compositor," has before him an oblong frame (or "case") divided into a number of small open boxes. One box contains the a's, another the b's, another the numeral 1's, another the numeral 2's, and so on. In his left hand the compositor holds a little steel receiving box, called a "stick." With his right hand he picks out from the "case" the letters he requires to form a word, and puts them one by one in his "stick." The stick is the same width as the column of his newspaper. Toward the end of each line in his stick he has to pad out the line with lead slugs so as to exactly fill the width of the stick; this is called "justifying." When he has a certain quantity of reading matter in his stick, say one tenth of a column in length, he transfers the type to a "galley" or long "stick." By and by, when the galley is filled up, the type in it is transferred to the large receiving form called a "chase," in which the columns of the newspaper are made up to be placed on the printing-press. Such, very roughly described, is the process of type-setting by hand.

After the paper is printed the compositor must pick out all the separate letters and numerals from the columns of type, and put them back in the proper boxes in his "case." This is called "distributing." The "distribution" occupies about one fifth of a compositor's whole working-time.

In all this, civilization is to-day where it was five hundred years ago, and almost where the Chinese were two thousand years ago. Alone of all the great inventions of man, type-setting has stood still from its birth until now. In war and in commerce, on our farms and in our workshops, in travel and in our homes, almost every mechanical process, once slowly and laboriously effected by manual or animal labor, has been quickened generation after generation by new appliances or inventions, save and except the work of type-setting That is as slow now as when Coster or Gutenberg did the first European type-setting early in the fifteenth century. Printing has otherwise moved with the rest of the world. Our printing-presses, our power, our folding and pasting machines, all are wonderfully improved. Nothing in all the world has developed more marvelously than the printing-press. But type-setting has stood still. The ordinary composing-room of to-day can work no faster and no better than the composing-room of the fifteenth century.

With the type-casting machine should come a new era. The operator needs only the intelligence which is required in a good compositor. He does not require more than one tenth the train-

ing. Thus equipped, he can, I believe, do steadily and regularly the work of three fair hand compositors. He does not handle type; has no "stick"; is not required to do any justification nor any distributing. He sits in front of a machine and works a key-board and a lever, and the machine does everything else.

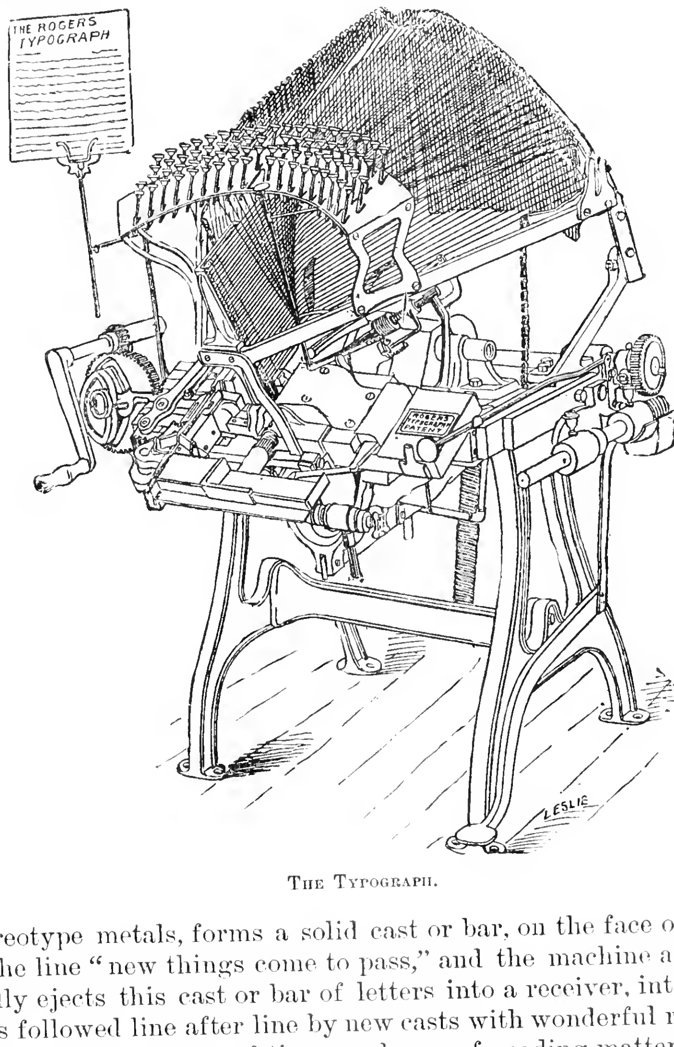
Now to outline the working of the type-casting machine. A key-board similar to that of a type-writer fronts the machine. There is a key for each letter of the alphabet. The operator sits in front of the key-board. Let us suppose that he wishes to set the word "new." He touches the key *n*. The touch on the key releases from a magazine in rear of the machine a mold, technically called a matrix, for the letter *n*. The matrix, which is of brass, slides down into a receiver near the key-board. Next, the operator touches the key *e*. A matrix for the letter *e* is released, and slides down alongside the letter *n*. The operator touches the key *w*. A matrix for *w* comes down and ranges itself alongside *e*. Now, in the receiver we have, what?—the word *new* in type? No, nothing of the kind. We have three little brass molds standing side by side, from which, if we poured molten metal into them, we would get the word *new* in a solid cast. But there is no type. The machine knows nothing of type whatever, though, for convenience' sake, we are calling it at present a type-casting machine.

But the time is not come to put molten metal into the three little molds or "matrices." An entire line should be set, not merely a word. Suppose the line is to be, "new things come to pass." The operator proceeds to touch key after key for the successive letters until the matrices for the whole line are ranged side by side. Now at this point comes in what was for years the great problem in type-casting by machinery. As the end of a line of matrices or type is approached, it may not be possible to fit in an even word or syllable. Padding, or "justifying," becomes necessary. In setting by hand, the compositor does this with little lead slugs, called "spaces," inserted between words. How is this to be done by a machine? Inventors long stuck at it. But they have found out how. The process is simple in action, though difficult to describe without a model. Roughly speaking, the "spaces" or slugs which are used between each word in the line of matrices are compensating wedges, the bottoms of which project below the matrices. When the line of matrices requires "justification," a touch on a lever by the operator causes the bottoms of the compensating wedges to be struck by a cross-bar, which forces the wedges up between the words until the line is solidly filled out.

The line of matrices or letter molds is then ready to receive a cast. Where is the molten metal? It is in the machine. This

wonderful apparatus has a furnace for a heart and a melting-pot for a stomach. The furnace, consisting of a series of gas-jets, and the melting-pot, are in the lower part of the body of the machine. In the pot, stereotype metal is melted. The pot is not very large, because fresh metal may be put into it at any time when needed. The same metal may be used over and over again as often as desired; it does not deteriorate.

A jet of molten metal is thrown into the matrices by a force-pump worked by the automatic action of the machine. The metallic fluid, hardening almost in an instant, a property of



THE TYPOGRAPH.

stereotype metals, forms a solid cast or bar, on the face of which is the line "new things come to pass," and the machine automatically ejects this cast or bar of letters into a receiver, into which it is followed line after line by new casts with wonderful rapidity, until in a short space of time a column of reading-matter in bars is ready for the press. The speed of the machine is measured by

the speed of the operator at the key-board. It can work as fast as he can.

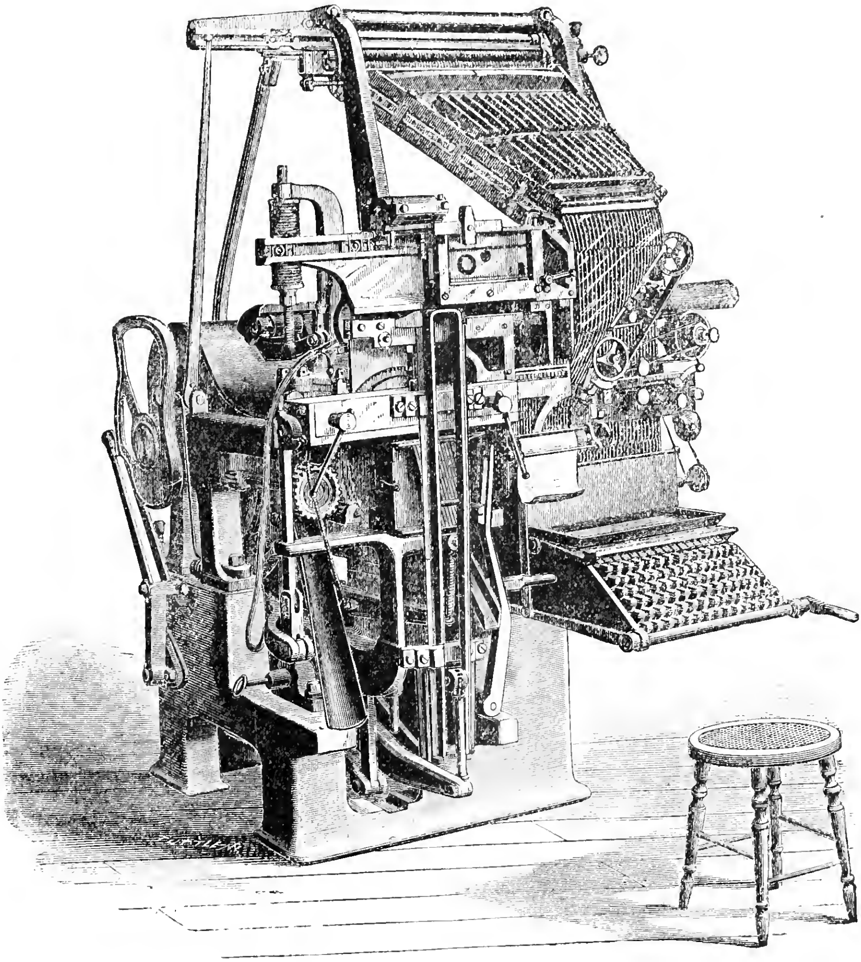
When a line of matrices has been utilized, the matrices must be returned to their channels ready for use again. This is accomplished by ingenious contrivances as soon as the cast has been made. The matrices being thus promptly returned, there is only need for a few of each letter. Thus a few dozen of the little brass molds do the work which in type-setting by hand needs a stock of from forty to fifty pounds of type.

The Rival Patents.—There are two type-casting machines on the market. These are the Mergenthaler or Linotype, and the Rogers or Typograph. The Linotype weighs a ton, covers floor space about six feet by six, stands seven feet high, and is sold for $3,000, or rented for $500 a year. I have seen an expert operator set at the rate of nearly eight thousand ems per hour on it from a phonograph communicating with his ear. The proprietors claim a regular practical speed of over four thousand ems an hour, which is four times the speed a good compositor averages by hand, if we include the time he must take for distributing. On the Linotype, the first time I ever touched a key-board, I set one hundred and fourteen ems of strange copy in six minutes, or at the rate of eleven hundred and forty ems an hour.

The Typograph weighs four hundred and fifty pounds, covers floor space four feet by four, is four feet six inches high, sells for $2,500, and rents for $365 a year. The proprietors claim a regular practical speed of three thousand to thirty-five hundred ems per hour. I have set one hundred and fourteen ems by the Typograph in nine minutes. At the end of each line the operator at the Typograph must stop to throw back the cap of the machine, a movement which restores the matrices to their magazines. The proprietors of the Typograph claim that it can work as fast as will ever be practically possible on any machine. In other words, they think that human beings will not be physically capable throughout a whole working day of requiring as great a steady speed as the Typograph can give.

The Typograph was submitted to a severe practical test in September, 1890, by the New York World. An eight-page section of the Sunday World, September 28th, was set by one machine working continuously day and night for one hundred and nineteen hours and thirty-five minutes, or nearly a week. The object of the test was to ascertain how the machine would bear a continuous steady strain. Three operators took eight-hour shifts at the work. The machine—I was informed both by the business manager of The World, Mr. Turner, and by one of the operators, the foreman of The World composing-room—stood the test almost perfectly. I measured the amount of setting done. It came to

one hundred and fifty-six thousand ems of minion. As the machine was worked one hundred and nineteen hours, this shows an average speed of only thirteen hundred ems per hour. At first sight this might seem disappointing. There were reasons why it was not so. The three operators were compositors, and had had only three or four weeks' practice on the Typograph. Owing



THE LINOTYPE.

to faults of the motor used to run the machine, it had to be worked by hand-power one quarter of the time. The three operators not only ran the machine, but they read the proofs, made the corrections, set the headings, and made up the "forms" ready for the press. Finally, the machine lost several hours' work through a fault in a casting. Taken as a whole, it seems to me the test was a conclusive proof of the practical success of the Typograph.

Type-setting by Machinery.—Type-casting is quite different from machine type-setting. Before contrasting type-casting with ordinary hand type-setting, it may clear the way to outline the principle of machine type-setting.

The type-setting machine has a reservoir of type, instead of a magazine of matrices as in the casting-machine; but, unlike the matrices, which return to their magazine the moment a line is cast from them, the type must go the whole way to the printing-press. Otherwise, the action of the type-setting machine is somewhat similar to that of the casting-machine. The type-setting machine is also worked by an operator at a key-board. When the operator touches a key, a type is released, just as a matrix is in the casting-machine, and slides into a receiver, where it is joined by other successive letters until words and lines are formed. As type is directly used, there is no furnace or melting-pot about the machine. This is the only advantage it has over the casting-machine, while compared with the latter it has serious drawbacks.

The type-setting machine seems to be a practical success, and an improvement on type-setting by hand; but, if for two reasons only, it is doomed to be superseded by the casting-machine. 1. It requires a heavy stock of type instead of a few matrices. 2. At least two attendants are required to each machine, one to operate the key-board, the other to justify the lines, attend to corrections and superintend matters generally, and to distribute the type again. Still, the business manager of the office in which the New York Forum is printed, informed me that through their use he is saving $1,700 a year in the setting of that monthly magazine, which does not require in a year as much composition as a daily paper in a month.

Comparison with Type-setting by Hand.—In any considerable quantity of straight reading matter, type-casting machines as compared with hand composition should, if working successfully, effect a saving of from one fourth to one third the cost of setting. Moreover, the setting is better. Perhaps this contention is best illustrated by figures. Those which I propose to give are based on the conditions prevailing in Canadian newspaper offices. Let us suppose an office in which one hundred and twenty thousand ems of straight reading matter are set per day in minion type. To fix ideas, we may describe this roughly as equal to about twenty-five ordinary newspaper columns. Many of the larger city papers in Canada print just about this quantity of reading matter per day. The union rate paid compositors in Canada is thirty-three and a third cents per one thousand ems. One hundred and twenty thousand ems would cost, therefore, about $40 for composition, apart from the cost of the type, foremen, office, etc. Forty dollars per day would come to $12,000 per year of three

hundred working-days. Now, let us see what it would cost to do the same amount of setting by the type-casting machines. These are claimed by their proprietors to work at the rate of three thousand to five thousand ems per hour in regular use. Making allowance for the probability that operators could not keep up such a speed all day, that mistakes have to be corrected, and accidental stoppages might occur, we may admit that the machines can set an average of twenty-five hundred ems per hour during an eight-hour day, or twenty thousand ems per day each, which is little more than half what the inventors claim as practical. Six machines could at this rate set one hundred and twenty thousand ems per day. As already said, to set this by hand would cost $12,000. The cost of the machine work would be—

Six machines at $500 rent each	$3,000
Six operators at say $14 per week	4,368
Gas, say	1,000
Repairs, etc.	500
Total	$8,868

Or equivalent to a saving of $3,132 on the setting by hand, or over twenty-five per cent. The estimate of $14 per week as a fair rate for operators of the machines is not too low for a Canadian office. First-class compositors certainly do not average more.

As a further illustration, I may give the actual figures of cost of a composing-room with which I am familiar. The setting amounts to about sixty thousand ems in a nine-hour day, done by ten to twelve compositors. A number of the hands are paid by the week, and the straight setting costs only about twenty-five cents per thousand; or, for sixty thousand ems, $15 per day—equal for three hundred days to $4,500 per year. There is also a foreman at $14, an assistant foreman at $12, and a couple of lads at $3 each. These four, costing $32 per week, or $1,664 a year, do all the setting of space advertisements. There is $2,000 worth of type, costing for interest say $140 per year, and requiring renewal at the rate of say $400 per year, or complete renewal once in five years. The cost of the composing-room is therefore somewhat as follows:

Composition by hand	$4,500
Foremen, etc.	1,664
Cost of type	540
Rent, heat, light, etc., say	500
Total	$7,204

To set sixty thousand ems in a nine-hour day, or six thousand seven hundred ems per hour, would require say three type-casting machines, which at $500 rent would cost $1,500 per year, and the composing-room figures would be:

Rent of machines	$1,500
Three operators at $14	2,184
Foremen, etc	1,664
Gas for machines, say	500
Rent, heat, light, etc	500
Total	$6,348

The saving would apparently be some $856, or over twelve per cent, while less room would be required, cleaner and better work would be done, the labor better paid, and a higher class of operators employed. Later I will touch on some reasons why it might not be safe to depend on type-casting machines in so small a business. In a larger business there is little doubt in my mind that the use of the machines is preferable to hand composition.

Finally, it is much easier to learn to operate the type-casting machine than to learn to set type. To set type at the rate of a thousand ems an hour requires two or three years of constant practice. To set a thousand ems on the type-casting machine in an hour requires no previous practice. It can be done the first time a person touches a key-board. This seems a strong statement to make, but I have the best of reasons for knowing it to be true. I did it, as already described. Previous to making the attempt I had never touched a key-board but once, and that was a dummy-board. I had never touched a type-writer or any other instrument the use of which might qualify one for operating the type-casting machine. Being in the rooms of the Linotype Company in New York recently, I asked and received permission to try the machine; and picking up a printed clipping from which the operator had been setting, I went to work and in six minutes set one hundred and fourteen ems, equal to one thousand one hundred and forty ems per hour, stopping because the clipping then ended. I repeated similar experiments on other machines subsequently, with much the same average result. In short, I was able to do with the machine at sight and without practice what it would take me years to learn to do by hand. As to becoming expert on the machines, a number of operators whom I have questioned agree that from three to six months' practice enables one to attain a speed of three thousand to four thousand ems from ordinary copy.

In fact, as I have stated, the only limit of speed on the Linotype is the rate at which the operator can move his fingers. He can not work quite so rapidly as a type-writer, because at the end of each line of matrices he must stop to touch the lever which sends the line off to receive a cast. Supposing we allow twenty-five per cent of his time for this, which is surely a large proportion, we can get an idea of the possible practical rate of the machine by comparing it with the possibilities of a type-writer.

Upon a type-writer, a rate of sixty words per minute from dictation is not very high. The Senate Hansard reporters of Canada employ several type-writers who average from sixty to seventy words and over for considerable periods of time. Allowing the speed of the operator on the type-casting machine to be twenty-five per cent less, we have at least forty-five words per minute as the practical rate of the machine. This is equal to seven thousand one hundred and five ems per hour. As already said, I saw one man at the Linotype set for half an hour from a phonograph at a rate of nearly eight thousand ems per hour, and the setting was as "clean" as that of the average compositor.

Summing up the comparison between hand setting and machine casting, I find: 1. The machine is much more easily learned. 2. No type is required. 3. Less space and fewer hands are needed in the composing-room. 4. Setting is cleaner, and probably one third cheaper. 5. Justification is automatic and perfect. 6. By changing the matrices, which can be done in half an hour, a different style of type becomes available. 7. "Leading" can be done much more quickly. 8. There is no "pi-ing," or mixing up of type. 9. Fewer typographical errors are likely. You do not have inverted letters, nor mistakes due to the type having been wrongly "distributed" in the case, which are a source of frequent typographical blunders.

Drawbacks and Possible Complications.—It will be asked, How is it that these remarkable machines have not at once sprung into popularity ?—so cheap, so rapid, so easily learned, so economical! How is it that so little has been heard about them ? Well, the patents were only perfected last year, and the machines are not yet being made fast enough to supply the demand. Meanwhile, there are many possible complications, the fear of which must cause the average printing-office to hesitate to try the machines. 1. The machines require power to drive them effectively. The failure of power for any reason would seriously interfere with them, although they can be driven by foot-power in an emergency. 2. They require gas or gasoline for their furnaces; the failure of the gas from leakage, or cold, or accident, would stop the machines. 3. The molten metal in the melting-pot must always be at a tolerably even temperature; otherwise the casting is bad, perhaps impossible. It is claimed that this difficulty has been overcome in the Linotype, and that the temperature of the molten metal is automatically kept at a temperature varying not more than 10° Fahr. A column of mercury is connected with the melting-pot, and when the temperature causes the mercury to ascend beyond a certain point, it lowers the gas-jets which supply the heat. When the mercury descends below a certain point, it turns on the gas more strongly. 4. The machines are composed of many

parts, and if they get out of order in a town in which expert mechanics are not at once available, their usefulness is gone for that day at least. 5. They can set only straight reading matter, so that advertisements, display headings, cross lines, italics, etc., must be set by compositors. 6. If a mistake of a letter is made in setting by the machine, the whole line must be recast, unless (which is not likely) the mistake is noticed the moment it is made and the operator stops to rectify it by changing the matrix. However, a whole line can be reset and recast almost as quickly as a compositor can correct by hand a mistake in a type letter. 7. It is a more serious drawback that if, in correcting proofs, it is desired to insert additional words, a number of lines may have to be recast. 8. The matrices in which the casts are made are possibly liable to wear a little, and so to soon make bad casts. Of course this can be remedied by getting new matrices, which are not expensive. 9. In a small office where two or three machines might be employed, there would probably be only two or three expert operators; if one took ill, the machine would become almost useless for the time being.

Present Practical Availability.—A small printing-office is hampered in many ways with regard to the use of machines, nor can it safely, at present, take the chances of break-downs. Where only three or four machines can be used, the stoppage of one means a loss of twenty thousand ems of setting per day. That is serious enough; but if the cause of stoppage should affect all the machines, there must be a business dead-lock, because small concerns, or rather concerns in the smaller centers of population, can not at slight notice secure a staff of compositors to replace the machines, or arrange for publication elsewhere. Even, therefore, were the machines being manufactured as fast as desired, it is questionable whether they would find a market at present outside the large cities where expert mechanics can be had to attend them at a moment's notice, and where arrangements for special help or special publication can be made in an hour, if necessary. But I think that in any office setting one hundred thousand ems a day, or over, it would pay the proprietors to at once procure machines sufficient to do at least half their setting, retaining a certain number of compositors with them. I can see no reason why this should not be a fairly safe experiment and a financial success.

The machines are available on a very liberal basis. Either company leases them at a moderate rental, agrees to take them back if not satisfactory, to keep them in repair while used, and to replace them with new machines in case of improvement of the patent.

The typographical unions admit that the machines must be

accepted as a practical fact. The International Typographical Union, at its last annual meeting in the United States, recommended its subordinate unions, in cities in which the machines come into use, to prepare a scale of prices for the work done, and to urge that union compositors be employed as operators. This is a sensible acceptance of a new order of things.

In conclusion, this is to be observed: There are theoretical objections to the machines in many small details which have not been touched on in this article, partly because I wish to present a clear general idea of the subject unencumbered by trivialities; partly because to handle them would require complicated and technical descriptions likely to confuse those who have not seen the machines, or who are not familiar with type-setting or stereotyping methods and appliances. With regard to such possible objections, it should be remembered that the type-casting principle scarcely now requires to defend itself against fanciful opponents. It has been tried, and not found wanting. As was stated at the outset of this article, a large number of Linotypes have been successfully employed for years in the composing-room of a leading New York paper. I have tried to deal with the chief possibilities of failure in the machine, and it has been noticed that these possibilities seem to be chiefly in connection with printing establishments of limited extent and means. Few of the drawbacks, it appears to me, would be serious in a large office employing machines, and located in centers where the prompt assistance of expert mechanics can be had, and my conviction of this is borne out by the New York Tribune's experience. Such a test as the Linotype has received in that office during five years is the most conclusive answer to technical or theoretical objections to the principle of type-casting The real problem with a publisher should be, not whether the machines are a success when used on a large scale, but whether his own business is large enough to justify him in introducing them into his own office. To use an exaggerated illustration, there is no question but that a steam-locomotive is an infinitely more useful, powerful, and, on a proper scale, more economical affair than a wheelbarrow; but a laborer building a bit of roadway may do better with the wheelbarrow.

Mr. Robert T. Hill has observed, near the springs and water-holes of the Cretaceous of central Texas, many workshops where the Indians manufactured spears and arrow-heads. Near an old Comanche trail in Travis County almost every flint seems to have been broken or tested. In evidence that the implements have been manufactured in the present century, the author adduces the facts that they are always found on the surface, and that the Indians have actually used them in their warfare with the white men.

BREATHE PURE AIR.

By the Rev. J. W. QUINBY.

ONE of the saddest sights of our civilization is the spectacle of disease and pain which confronts us on every side. It is rare indeed to find even an individual perfectly well, to say nothing of families and communities. But why is it?

Barbarians and savages do not so suffer. May it not be, in part, because civilized communities do not sufficiently avail themselves of the sanitary influences of the air and light? It is in the hope of helping to answer this question that the following notes of personal experience are herewith given.

A few years ago I read an article in the Popular Science Monthly which seemed to prove the value of pure air as a preventive of "colds." The theory suggested was that colds may be caused by the loss of a certain equilibrium between the oxygen in the lungs and the carbon in the blood. It is true that this may follow overeating, and so overcharging the blood with food elements; but more frequently, it was thought, the lack of pure air.

By acting upon this theory almost incredible results were said to have been reached. The writer of the article alluded to claimed that he had easily brought himself into a condition in which it seemed impossible to take cold. He could sit in thin clothing in winter at an open window. The ordinary causes of colds, such as wet feet, overheating, and the like, seemed powerless to produce their usual results.

With these statements in mind, I remembered some curious facts of my own experience in the army in 1862 and 1863. I was not strong, and indeed was hardly fit to be in the army at all. And when I found myself exposed all day long to a steady rain, and at night to the outdoor air, with no fire, no change of clothing, no shelter but a canvas covering open at both ends, through which the rain dripped constantly, it seemed certain that the "death o' cold" so often predicted must surely follow. Why it did not follow was more of a mystery then, however, than it is now. For I was in a place where the art of man no longer excluded one of the prime principles of health. I breathed pure air because I could not help it. During a service of fifteen months, with severe exposures, but fresh air constantly, the same immunity from colds prevailed. I remembered, too, that when I came home from the army the blessing and the curse—at least one of the curses of civil life—came back together. I had comfortable rooms to eat, breathe, and sleep in on the one hand, but very soon colds, sore throats, and related troubles on the other. This was the second count in the argument for pure air.

Finally, after nearly twenty years of suffering according to the common lot of man, I resolved to try the pure-air cure, and from that time to this the windows of my room have been open almost constantly day and night. The result was immediate and striking, and for the last seven years I have not had one serious cold. My sore throats are wholly a thing of the past, and certain other physical derangements not usually associated with colds have also disappeared.

Like others, I have often to spend hours in crowded rooms. It sometimes happens after such an "exposure," as I prefer to call it, that I suffer for a day or two from a "head-cold." But in every case so far it has proved to be entirely superficial—a natural and easy throwing off of the poison contracted in that crowded room, followed by no serious effects whatever.

At this very moment in the house where I live there are twelve persons, every one of whom, except myself and one other, is suffering from the effects of a cold. It certainly does look as if the exemption I enjoy is due to the exceptional privilege of the pure air to which I constantly treat myself. Perhaps it would help the argument to state that nearly all of my father's large family died of consumption.

It should be borne in mind that the difference between the air of an ordinary room in which people live and that of the air outdoors is far greater than is generally supposed. Do but think of the emanations that constantly proceed from every object in such a room—carpets, walls, and draperies. People say: "Oh, yes, we believe in ventilation. We open the windows in the morning and let the air draw through; and at night we open the doors of our sleeping-rooms. We believe in pure air." And I feel like saying to them: "My dear friends, you know no more of really pure air than the blind mole down in the ground knows of sunlight."

I would not by any means advise persons who have been living in a close atmosphere to suddenly sit or sleep in the draught of an open window. It is only by degrees that such changes can be made with safety. But by degrees they can be made, and why might not most people begin at least to make them?

In the town where I live, in Massachusetts, a new system of ventilation required by the State has recently been put in operation in the high-school building. By means of it thirty cubic feet of air, it is said, are furnished to every pupil every minute. It seems to me this forward step in so vital a matter should be heartily approved by every lover of humanity.

Meanwhile, it is painfully apparent that multitudes of people, sick with constantly recurring diseases of the lungs and related parts, continue to breathe the old foulness. Is it not worth while

to make some effort to change this condition of things? Perhaps half the money now spent on superfluities, if devoted to a better system of ventilation, might very sensibly improve the health and increase the happiness of the community.

DRESS AND ADORNMENT.

IV. RELIGIOUS DRESS.

By Prof. FREDERICK STARR.

UNDER this subject we shall consider a variety of different matters—the dress of religious officers; the dress of worshipers; the dress of victims; the garb of mourners; amulets and charms; and the religious meaning of mutilations.

In any society we need *to know* four individuals only—the babe, the woman, the priest, and the dead man. If we know these, we know the community. The ethnographer usually seeks for the average man in any tribe; we believe he would better seek to know these four. Of the four the priest is usually the most remarkable. What an influence the shaman or the medicine-man wields in every community where he exists! His power is largely due to the terror which he causes, and to add to this he makes use of every auxiliary. Thus in his dress he aims at the wild and grotesque. By it he seeks to mark himself off as distinct from common men, and, although it may often be rich and costly, it must at the same time strike terror. The Kaffir sorcerer wears the ordinary kilt, but puts a gall-bladder in his hair and winds a snake's skin about his shoulders. A "queen of witches" wore large coils of entrails stuffed with fat about her neck, while her hair was

Fig. 1.—Necklace of Sorcerer. Zululand.

stuck over in all directions with the gall-bladders of animals (Wood). In any collection of articles from Alaska tribes a large proportion of the specimens will be garments or paraphernalia of the shaman. A Tlingit shaman fully dressed for his professional duties is a striking and terrible sight. Over his shoulders he wears a neat robe of dressed skin, to which are hung

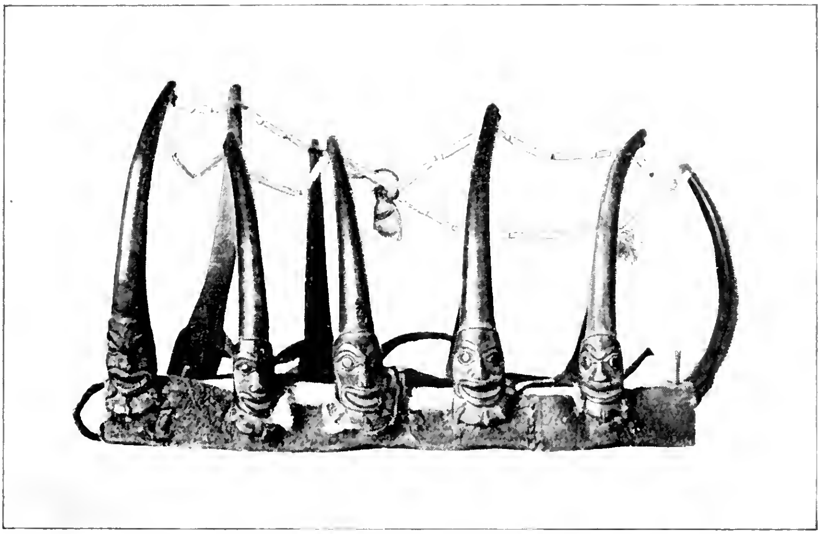


Fig. 2.—Shaman's Crown. Alaska.

the beaks of puffins, ivory charms, and jingling bits of metal. The charms are many of them neatly carved, and possess great spirit power in the cure of disease and the driving out of witches. A waist robe of the same material is adorned in the same way. Upon his head the shaman wears a crown of horns. These crowns are endowed with great spirit power. They are particularly interesting also as an unusually fine example of our old law—that old patterns are copied in new materials. The oldest type of these crowns was made from mountain-goat horns. These were simply carved with some design at base and were then attached to a head-band—the upper ends of the horns being connected with one another by a sinew cord. From ten to fifteen horns were used in a single crown. Later this type was copied in mountain-sheep horn and in wood—the material being carved out into little bodies, like the horns of the mountain goat in size and shape. Still later copper was rolled into horn-shaped cones, which were then connected in the same way. Over his face the shaman may wear a wooden mask skillfully carved with grotesque designs. These vary infinitely, but each part usually has its own meaning and spirit power. Often there was worn a head-dress of human hair. In the hands the shaman carries carved rattles

which make a loud noise, or carved wands of wood or ivory, powerful in healing or in witchcraft. It must be noticed that here every article has spirit power, and all or nearly all are calculated to inculcate feelings of terror or dread. There are some special articles, at times worn or carried by the shaman, which are very interesting. Among them are the curiously carved hollow bone tubes, used by the Haida shamans, into which the soul of a sick man is tempted and kept prisoner until it is restored to him upon his recovery to health. Every Tlingit shaman would carry also a scratcher of stone or bone, carved neatly, which he uses in treating the sick. It would be unlucky—disastrous—for him to touch the patient with his hand, but the scratcher may touch him without damage.

Turning from such savage garments to the dress of religious officers in civilized communities, we no longer find the chief design to be production of terror, but rather to impress by grandeur or magnificence. Of course, the *fundamental* idea in both is the same—to mark off or distinguish the priest from the layman. In the vestments of priests we find numerous cases of *survival*. What is meant by a "survival" in religion is well shown by the sacred fire of various peoples. Among the Sacs and Foxes matches made by white men are commonly used for the production of fire. On the occasion of religious ceremonies, however, the priest kindles a fire by friction of pieces of wood, using a spindle of cedar rapidly whirled by a bow between two boards of the same kind. Such fire is sacred, and is supposed to come direct from heaven. It is, we think, perfectly certain that anciently these Indians used the fire-drill as their only means of kindling fire. As better means, such as flints, were found, the old drill passed out of every-day use, but it lingered on in religious rite, and still survives. In the same way, in Japan to-day, we are informed by a Japanese friend, the Buddhist priests still use the flint

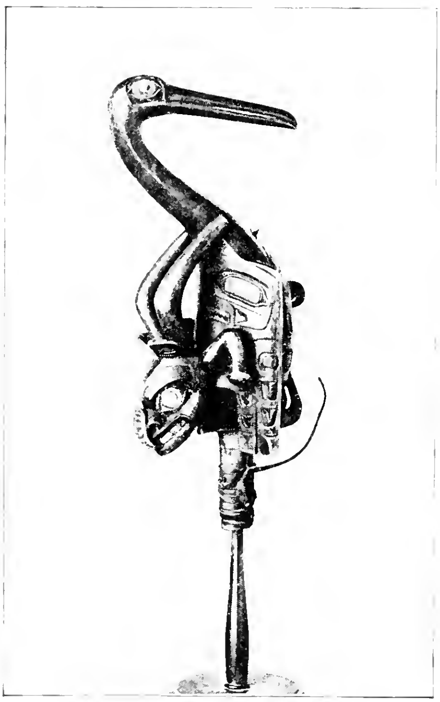


Fig. 3.—Dance-rattle. Alaska.

and steel in rites, although the common people use matches. What the Indian medicine-man in Iowa and the Buddhist priest in Japan have done in the matter of fire-making, the priests of the Roman and Greek churches have done in the matter of dress. They have brought down the past into the present. The garments of the priesthood, of the acolytes and of the choir-boys in the cathedral, is the civil dress of ancient Rome—modified, it is true, and symbolical in its modification, but still recognizable. It is the old southern type of dress, preserved by the second great conservative element in society — the Church — just as it has been by that other conservator, woman.

Fig. 4.—Carved Spirit-wands. Alaska.

In many parts of the world mendicants and fakirs are numerous. They are men who on account of their piety expect to be supported by their more industrious but less pious fellows. Such dress in a way to be readily recognized. In the garb they wear two ideas are embodied: (1) individualization; (2) extreme simplicity symbolical of the poverty of the mendicant.

Another sort of religious dress is that worn by the worshipers of some special divinity by members of religious orders and by participants in some religious service. These are too numerous and varied to be more than mentioned. In some of these cases the dress is symbolical; in many the symbolism has been lost. Monastic orders have their characteristic dress, distinguishing them alike from the world and from each other. Shakers, Quakers, and Dunkards all present examples of this kind of dress. The choir-boys in the cathedral and the acolytes might perhaps be better mentioned here than in the preceding group. Matthews, in his descriptions of Navajo ceremonies and dances, describes carefully the way in which the participants dress or are painted. Many of the masks from the South Sea Islands are used only in religious or society dances, and are properly a part of religious

dress. The same is true of many of the masks of North American tribes. Similar in idea are the curious and often really beautiful neck-girdles of red cedar bark worn by the secret religious organizations of the Kwakiutl and their neighbors in the far Northwest.

Somewhat akin to dress worn by worshipers and servants are those garments worn by victims who are to be sacrificed to the gods. At Teotihuacan in Mexico there have been and still are found great numbers of neatly made little terra-cotta heads of human beings. These are exceedingly various in design, the differences being most marked in the head-dresses. There is considerable uncertainty as to the purpose of these little heads, but Mrs. Zelia Nuttall has written an article wherein is offered an explanation that seems plausible. She suggests that they were buried with the dead, and that the head-dresses represent those worn by victims for sacrifice. That such victims were differently adorned for different gods is certain, and it may be that these pretty little relics really give representations of the way in which they were dressed.

Some time perhaps civilized peoples will give up the wearing of mourning for the dead. Why should any men or women force their private griefs upon all about them? Why increase the dolefulness of death? No doubt many who wear black would say that they do so from respect for the dead. Is it not in reality because fashion dictates it? Mourning dress is nothing new, nor is it confined to civilized races. Nor is the color of mourning a fixed thing. Black is very widely used, but some peoples use white. In New Zealand old people paint themselves freely with red ochre and wear wreaths of green leaves. Besides the wearing of a peculiar garb or of a special color to show grief, the mourners may disfigure themselves, or they may wear some relic of the dead friend. The curious practice of cutting off joints of the fingers is wide-spread. Among some American tribes, among Australians, Africans, and Polynesians it is a sign of grief. The Fijians used to chop off finger-joints to appease an angry chieftain, or for death of a relative, or as a token of affection. In Tonga finger-joints were cut when a superior relative was ill. In all these cases pres-

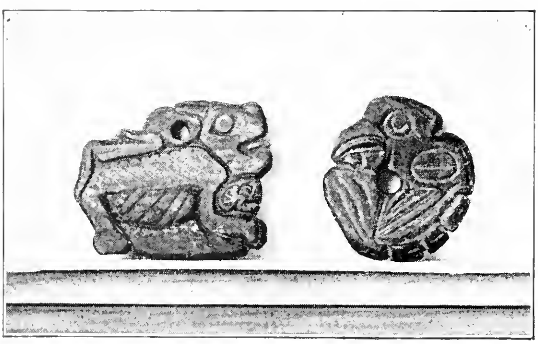


Fig. 5.—Carved Stone Charms. Alaska.

ent grief did not blind the mourner to future convenience, and the joints cut were usually from the fingers of the left hand. In the Andaman Islands, when a child dies it is buried under the house floor and the building is deserted for a time. Finally, the family returns; the bones are dug up and the mother distributes them among friends as mementoes. These bits of bone are generally worn as parts of necklaces. In Tasmania and Australia portions of the dead are prepared with some care and worn as sacred and loved objects. Thus the zygomata are broken from a child's skull, sinews of kangaroo are passed through the orbits, and the whole is worn about the mother's neck. A lower jaw may be carefully and neatly wrapped with sinew cord from one condyle to the other and supplied with a suspension cord. Long bones, entire or partial, were wrapped and worn in the same way. These objects were all highly prized, and Bonwick says, "So many skulls and limb bones were taken by the poor natives when they were exiled, that Captain Bateman tells me that, when he had forty with him in his vessel, they had quite a bushel of old bones among them." These were in Tasmania, but similar relics abound among the Andamanese. In Australia drinking-cups were made from the skulls of the nearest and dearest relatives and carried everywhere. The lower jaw was removed, the brain extracted, and the skull cleaned; a rope handle of bulrush fibers was added, and a plug of grass was put in the vertebral aperture. All these may be considered as examples of *mourning dress*. There has also been a great variety of dress for the corpse itself. To describe such dress in any detail would be too much. Black is often used for shrouds. In the Tales of Hawaii, as narrated by King Kalakaua, frequent reference is made to the wrapping of the dead in the black *kapa*. In the Society Islands the dead chief is laid out in a special dress of shell.

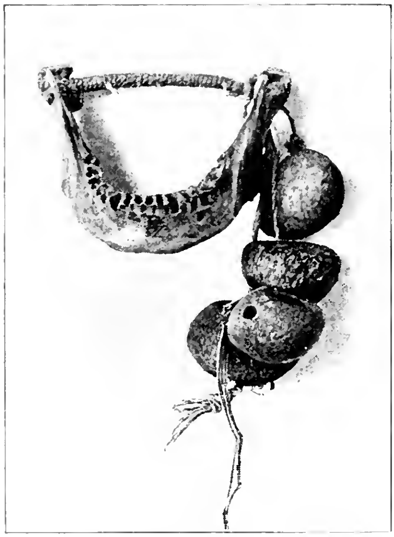


Fig. 6.—Dance Ornament for Arm. Made from human jaw-bone and empty nutshells. New Guinea.

In connection with relics of dead friends used as a part of costume, it may be pertinent here to refer to curious preserved heads found among various tribes. They may be simply the heads themselves, as trophies of war or reminders of friends, or they may

be masks made in part from the heads of the dead. The former are hardly a part of dress; the latter are. Both kinds will be considered. The Dyaks of Borneo are famous "head-hunters," and often prepare their trophies with great care. Barnard Davis had several specimens in his great collection, and he describes them in his Thesaurus. One was a whole skull: the lower jaw was stained inside to a deep red; it was fastened to the cranium by rattan; light, soft wood was fitted in the places of the teeth, into the nostrils, and into the ear-holes; other inequalities were filled with red-brown resin. The entire skull was covered with tin-foil; two cowrie-shells made the eyes; a small tuft of beard was made of stiff black hair; on the vertex and sides of the calvarium an ornamental, regular, and symmetrical device was cut through the tin-foil and painted red. These heads vary greatly in pattern and treatment. They were kept in head-houses, and were looked upon as treasures and as sacred objects. In the Solomon Islands, the Marquesas, and New Zealand we find heads preserved for one or another reason. Among the strangest of these most curious relics are the heads prepared by the Jivaros of South America. These are trophies of war. The heads are cut from the bodies of slain enemies; the brain and bones are removed through the neck; the whole head is then shrunken down. The result is a strange, diminutive, black head, with abundant and long hair, and with features all preserved, but so small as to be hardly recognizable as those of a human being. In all these Jivaros' heads the lips are sewed together with cords, and in some cases spiked together in addition. If Bollaert is to be trusted, this is done in order that the head may not answer the abuse that is heaped upon it at times! In the same part of the world, among the Mundurucus, are other interesting preserved heads. These are of full size; they are partly shaved; ornaments of feathers are hung at the ears; the eye-sockets are filled with black gum, into which are inserted bits of shell. These heads are apparently those of friends, not of enemies. In some respects akin to these real preserved

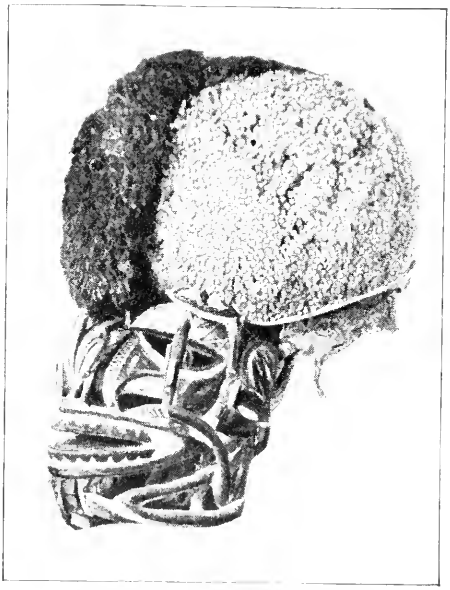


Fig. 7.—Dance-mask. South Seas.

heads are the very curious skull-masks from certain South Sea Islands. These are built up from parts of human skulls, pieced out with wood, cements, hair, and ornaments into horrid representations of faces. These are worn in dances and hence are true objects of dress.

The subject of amulets and charms would, of itself, furnish more material than could be used in our whole course of lectures. Scarcely any trinket or odd object exists that may not be worn upon the person "for luck," or to ward off danger or harm. All peoples use them. Savage, barbarian, and civilized man are alike here. Nubians are inveterate wearers of charms. Theirs usually consist of something done up in a red leathern case; the contents must not be known. *For what* will charms not be worn? I know American mothers who buy seeds—"Job's tears"—at drug-stores, to string them into a necklace to hang about the baby's neck to ward off eye troubles. The Bechuana mother strings beetles of a certain species and hangs them about the neck of *her* baby to help it in teething. Prof. Putnam found metacarpal bones of birds buried with babies in the little graves which he discovered under the hard clay floor of old house circles in Arkansas and Missouri. From analogy with modern Indian customs, he believes these were charms to help the child in cutting its teeth. We can not find that asafœtida is a specific for or a preventive of diphtheria, but we *did* find a small Afro-American who wore a little bag of it about his neck as a charm against the disease. Hundreds of Roman Catholic boys do not take off the medals they wear about their necks when they go in swimming, as these are a sure preventive against drowning. One of the most precious and beautiful amulets of history is that of which Moncure D. Conway tells us. It was a treasure from the past, owned by the Emperor Louis Napoleon III. It was set with a blaze of precious stones, the gifts of many princes. It descended to the Prince Imperial, who wore it as a watch-charm. He wore it when he was killed among the Zulus, and it is gone, no one knows where. Ah! if he had but known the rules

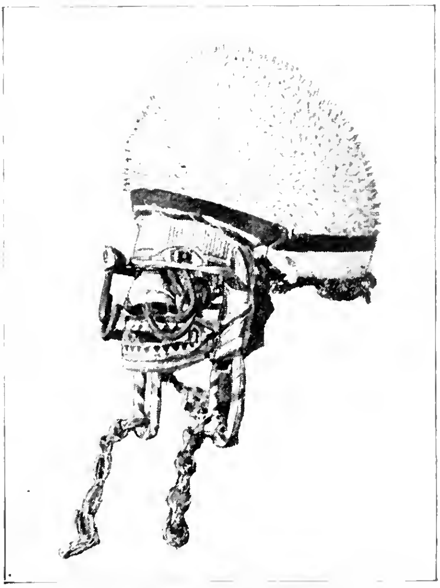


FIG. 8.—DANCE-MASK. South Seas.

of amulet-wearing among those people, and had worn it about his neck! No matter how precious it was, it would then have been left untouched The dead of battle may be stripped of every garment or ornament but that about the neck. No doubt the priceless talisman of centuries is now the choicest decoration in some neck ornament of claws and teeth and feathers. The most interesting charm of the American Indians is the "medicine." This may be almost anything to which the superstitious barbarian attributes some supernatural power. Commonly it is the skin of some animal. In many tribes, the boy who is approaching manhood withdraws to the woods or to some lonely place, where he undergoes a long fast. Weakened by his abstinence, he falls into a slumber, in which he dreams of some animal. With recovered consciousness he hunts for an individual of this species, kills it, and with great care removes the skin. This is his "medicine," and to increase its power various articles may be inclosed within it. To part with his medicine would be most unlucky; worn or carried upon the person, it serves as a powerful protector. We once purchased a medicine-bag from a Fox Indian. Its original owner was dead. It was kept in a small pouch of worsted, and consisted of the skin of a mole, carefully tied up and containing five different kinds of roots and barks. One of the most intelligent Indians in the tribe refused to look at the contents, assuring us that it would cause him bad luck, and was disrespect to the man whose protector it had formerly been. Among many Mohammedans we find amulets worn which consist of little pouches containing strips of parchment, on which are written passages from the Koran. This suggests certain practices of the Jews, both ancient and modern. One evening we had occasion to have a little Russian Jew boy try on some garments. Several of his young friends came with him. When he had removed his jacket and shirt, one of the boys eagerly called our attention to a queer little knitted garment worn over the undershirt. At its four corners hung bits of blue worsted twisted into a sort of tassel. The garment had little corner pockets into which these blue twists might be tucked. "Did you ever see that

Fig. 9.—Terra-cotta Head. Mexico.

kind that Abraham has on?" asked Sammie. "No," we replied; "what is it for?" Abraham himself replied that it was something he wore for luck and to help him, and that every morning when he said his prayers he kissed these blue cords. We found that most of the boys had these, though one said he had not, but his father wore a large one which he let him kiss every day. Sammie told us that he had a different kind which he wore on his arm and on his forehead; that it was made of leather. He volunteered to show us one, which he did a few days later. Before he put this on for us he washed his hands and face and brushed his hair. He also fasted until he took it off, as he said he never wore it except before breakfast. Whatever the fringes of the garments and phylacteries may have been once, they are now, with these children and the more ignorant of the adult Jews, nothing more nor less than charms. It will here be of interest to quote some references to these things. In Numbers, xv, 38–41: "And the Lord spake unto Moses, saying: Speak unto the children of Israel, and bid them that they make them fringes [tassels in the corners] in the borders of their garments throughout their generations, and that they put upon the fringes of each border a cord of blue: and it shall be unto you for a fringe, that ye may look upon it, and remember all the commandments of the Lord, and do them. . . . That ye may remember, and do all my commandments, and be holy unto your God. I am the Lord your God, which brought you up out of the land of Egypt, to be your God."

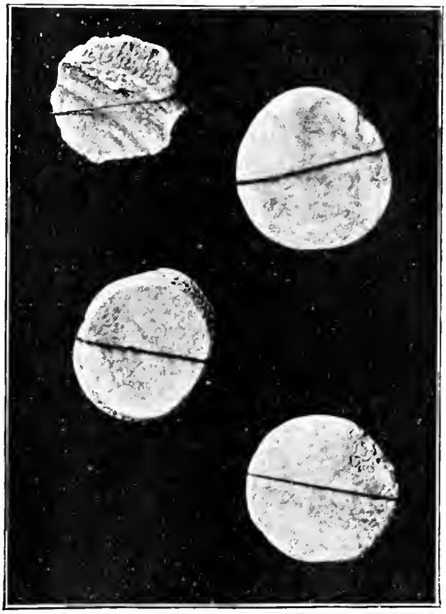


FIG. 10.—DISKS CUT FROM HUMAN SKULL, USED AS CHARMS. Illinois Mound.

As to the phylacteries, there is no such explicit direction as to their making. The details were, however, very exactly arranged by the religious teachers. The leathern boxes could be only made of cowskin; the thongs must be applied to the left arm and forehead in a particular way. The little box contains four passages of Scripture—Exod. xiii. 2–10, 11–14; Deut. vi, 4–9, 13–22—written on rolled strips of parchment. The ink used must be of a particu-

lar kind. The purpose was to remind the Israelites of the "bringing up out of the land of Egypt." The passages refer to that event and also to the command, which forms the excuse for the phylactery itself: "And these words which I command thee this day shall be in thine heart: . . . And thou shalt bind them for a sign upon thine hand, and they shall be as frontlets between thine eyes."

We shall close this rather rambling lecture with some suggestions relative to the religious meaning of mutilations, some of which were described in our first lecture, on deformations. We must first realize how savage and barbarous man looks upon blood. To begin with, he personally *loves* warm blood. He delights to drink it, to eat flesh reeking with it, to dip his hands into it, to splash his face and body with it. He has also some curious notions regarding it. A Brazilian bathes his infant in his enemy's blood, in order that the child may grow up a brave warrior. In Oceania the warrior dips his lance-tip into the blood of his slain foe to render himself invincible. In New Zealand the body of the dead foe was eaten in order that his blood might render the victor the heir of his bravery. Now, when savage and barbarous man, with his love for and his notions regarding blood, comes to think of higher beings, invisible but potent, whom he wishes to ally to himself, how can he better gain their friendship than by offering to them blood? And the *best* sacrifice is his own blood. Here we have the fundamental idea of every blood covenant. There are of course in any one instance other ideas present. But whatever these various significant features may be, in all we see a man trying to establish an artificial relationship with a deity by the shedding of his own blood. The people of any one clan or family worshiping the same god, the peculiar mode of shedding blood prevalent among them might become a tribal mark or sign. In Jewish circumcision — not originally Hebraic, but Egyptian—we see a good illustration of a blood covenant giving rise to a characteristic tribal mutilation. We see, too, in it very clearly a substitute for human sacrifice (see Exod. iv, 24). In Gen. xvii, 7, 10, 11, 17, 23: "And I will establish my covenant between me

Fig. 11.—Portion of Human Skull from which Charms have been cut. Illinois Mound.

and thee, and thy seed after thee, in their generations, for an everlasting covenant; to be a God unto thee, and to thy seed after thee. . . . This is my covenant: . . . Every male child among you shall be circumcised; . . . and ye shall circumcise the flesh of your foreskin; and it shall be a token of the covenant betwixt me and you. . . . And Abraham took Ishmael his son, and all that were born in his house, and all that were bought with his money, every male among the men of Abraham's house; and circumcised the flesh of their foreskin, in the self-same day, as God had said unto him." We have no time, nor is it pertinent here, to consider all that circumcision has to teach, nor to trace its wide-spread practice in varying forms. Enough to say that everywhere we find underlying it the idea of sacrifice of one's own blood as a symbol of compact with some deity, more or less clearly. The Jew and the Egyptian circumcised, but many peoples do not do so. Such may, however, have some other bodily mutilation; for instance, a perforation as the sign of a blood covenant. Wherever the part of the body operated upon was visible to every passer, and the operation itself was a perforation, it might be that some object might be inserted in the opening to keep it open and to render it conspicuous. In such a way may have arisen the use of labrets and earrings. These plugs, at first rude, may become beautiful. When this occurs, the original religious idea may be lost sight of, and the perforation may still be made simply to admit of ornaments being worn.

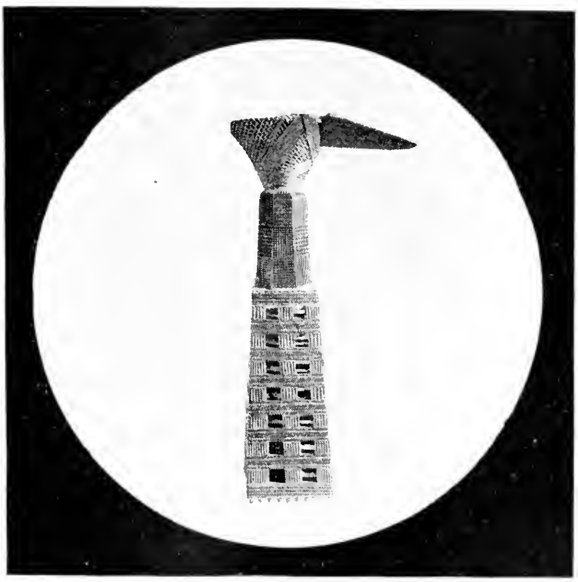


Fig. 12.—Ceremonial Stone Adze with Carved Handle. South Seas.

The history of the ear perforation is particularly interesting. In its origin this is no doubt as truly a sign of a blood covenant as is the Jewish circumcision. It seems possible that the ancestors of the Jews were in compact with a god whose sign of covenant was ear-piercing. After this god was renounced and Jehovah

accepted, ear piercing among them was heathenism. Whether this is so or not, it is certain that the descendants of Ishmael were in covenant with such a god.

Judges, viii, 24, 25: "And Gideon said unto them, I would desire a request of you, that you should give me every man the ear-rings of his prey. For they had golden ear-rings, *because* they were Ishmaelites. And they answered, We will willingly give them. And they spread a garment, and did cast therein every man the ear-rings of his prey." And the suggestion of the same thing is very strong in Genesis, xxxv, 4: "And they gave unto Jacob all the strange gods which were in their hand, and all their ear-rings which were in their ears; and Jacob hid them under the oak which was by Shechem."

This sign of covenant with some other god than Jehovah crept at an early day, like so many other customs of heathenism, into the Christian Church. It has gradually disappeared. Lippert says that in the early Church it was customary to have the ears pierced, at the same time invoking the protection of saints against disease. Gradually this dwindled to invocation of a single saint's assistance against a single class of diseases—those of the eye. A remnant of this still lingers among those people who, in our own day and land, claim that they pierce their ears to help their eyesight. Such persons present us the last picture in a series the first of which is a savage man, whose ears are pierced merely to shed blood for the gratification of a deity whose aid he desires to secure.

We have thus considered a large number of curious and interesting points regarding dress and adornment. We have seen how the curious deformations so widely practiced have arisen, and how they are useful. We have queried as to the motives which have led to dress development and its results. We have emphasized the influence that the desire for adornment has exercised upon man's progress. We have lastly shown how a large number of articles of dress and ornament have come to have a religious significance, and how many other deformations have begun in connection with acts of worship.

The remains of an extinct species of swan are described by Mr. H. O. Forbes, Director of the Canterbury Museum, New Zealand, as having been found in a newly discovered cave near Christchurch. Moa bones, with Maori relics—including implements, carvings, a lock of hair carefully done up, and other hair—were found so associated as to "show incontestably" that the Maori and moa were contemporaneous. Remains of various animals and other birds than the moa, which had been used for food, were found, but no human bones. Some of the birds appear to have been of species now extinct in New Zealand, and not elsewhere described.

SOME OF THE POSSIBILITIES OF ECONOMIC BOTANY.*

By GEORGE LINCOLN GOODALE.

[*Concluded.*]

III. FRUITS. — Botanically speaking, the cereal grains of which we have spoken are true fruits, that is to say, are ripened ovaries, but for all practical purposes they may be regarded as seeds. The fruits, of which mention is now to be made, are those commonly spoken of in our markets as fruits.

First of all, attention must be called to the extraordinary changes in the commercial relations of fruits by two direct causes:

(1) The canning industry, and—

(2) Swift transportation by steamers and railroads.

The effects of these two agencies are too well known to require more than this passing mention. By them the fruits of the best fruit-growing countries are carried to distant lands in quantities which surprise all who see the statistics for the first time. The ratio of increase is very startling. Take, for instance, the figures given by Mr. Morris at the time of the great Colonial and Indian Exhibition in London. Compare double decades of years:

1845, £886,888.
1865, £3,185,984.
1885, £7,587,523

In the Colonial Exhibition at London, in 1886, fruits from the remote colonies were exhibited under conditions which proved that, before long, it may be possible to place such delicacies as the cherimoyer, the sweet-cup, sweet-sop, rambutan, mango, and mangosteen at even our most northern seaports. Furthermore, it seems to me likely that, with an increase in our knowledge with regard to the microbes which produce decay, we may be able to protect the delicate fruits from injury for any reasonable period. Methods which will supplement refrigeration are sure to come in the very near future, so that, even in a country so vast as our own, the most perishable fruits will be transported through its length and breadth without harm.

The canning industry and swift transportation are likely to diminish zeal in searching for new fruits, since, as we have seen in the case of the cereals, we are prone to move in lines of least resistance and leave well enough alone.

To what extent are our present fruits likely to be improved? Even those who have watched the improvement in the quality of

* Presidential address delivered before the American Association for the Advancement of Science, at Washington, August, 1891.

some of our fruits, like oranges, can hardly realize how great has been the improvement within historic times in the character of certain pears, apples, and so on.

The term historic is used advisedly, for there are prehistoric fruits which might serve as a point of departure in the consideration of the question. In the ruins of the lake-dwellings in Switzerland * charred apples have been found, which are, in some cases, plainly of small size, hardly equaling ordinary crab-apples. But, as Dr. Sturtevant has shown, in certain directions there has been no marked change of type; the change is in quality.

In comparing the earlier descriptions of fruits with modern accounts it is well to remember that the high standards by which fruits are now judged are of recent establishment. Fruits which would once have been esteemed excellent would to-day be passed by as unworthy of regard.

It seems probable that the list of seedless fruits will be materially lengthened, provided our experimental horticulturists make use of the material at their command. The common fruits which have very few or no seeds are the banana, pineapple, and certain oranges. Others mentioned by Mr. Darwin as well known are the bread-fruit, pomegranate, azarole or Neapolitan medlar, and date palms. In commenting upon these fruits, Mr. Darwin † says that most horticulturists "look at the great size and anomalous development of the fruit as the cause and sterility as the result," but he holds the opposite view as more probable—that is, that the sterility, coming about gradually, leaves free for other growth the abundant supply of building material which the forming seed would otherwise have. He admits, however, that "there is an antagonism between the two forms of reproduction, by seeds and by buds, when either is carried to an extreme degree, which is independent of any incipient sterility."

Most plant-hybrids are relatively infertile, but by no means wholly sterile. With this sterility there is generally augmented vegetative vigor, as shown by Nägeli. Partial or complete sterility and corresponding luxuriance of root, stem, leaves, and flower may come about in other obscure ways, and such cases are familiar to botanists.‡ Now, it seems highly probable that, either by hybridizing directed to this special end, or by careful selection of

* Carbonized apples have been found at Wangen, sometimes whole, sometimes cut in two, or, more rarely, into four pieces and evidently dried and put aside for winter use. . . . . They are small and generally resemble those which still grow wild in the Swiss forests; at Robenhausen, however, specimens have occurred which are of larger size, and probably cultivated. No trace of the vine, the walnut, the cherry, or the damson has yet been met with, but stones of the wild plum and the *Prunus padus* have been found." Lubbock, *loc. cit.*, p. 217.

† Animals and Plants under Domestication (American edition), vol. ii, p. 205–209

‡ Gray's Botanical Text Book, vols. i and ii.

forms indicating this tendency to the correlated changes, we may succeed in obtaining important additions to our seedless or nearly seedless plants. Whether the ultimate profit would be large enough to pay for the time and labor involved is a question which we need not enter into; there appears to me no reasonable doubt that such efforts would be successful. There is no reason in the nature of things why we should not have strawberries without the so-called seeds; blackberries and raspberries, with only delicious pulp; and large grapes as free from seeds as the small ones which we call "currants," but which are really grapes from Corinth.

These and the coreless apples and pears of the future, the stoneless cherries and plums, like the common fruits before mentioned, must be propagated by bud division, and be open to the tendency to diminished strength said to be the consequence of continued bud-propagation. But this bridge need not be crossed until we come to it. Bananas have been perpetuated in this way for many centuries, and pineapples since the discovery of America, so that the borrowed trouble alluded to is not threatening. First we must catch our seedless fruits.

Which of our wild fruits are promising subjects for selection and cultivation?

Mr. Crozier, of Michigan, has pointed out* the direction in which this research may prove most profitable. He enumerates many of our small fruits and nuts which can be improved.

Another of our most careful and successful horticulturists believes that the common blueberry and its allies are very suitable for this purpose and offer good material for experimenting. The sugar-plum, or so-called shadbush, has been improved in many particulars, and others can be added to this list.

But again we turn very naturally to Japan, the country from which our gardens have received many treasures. Referring once more to Prof. Georgeson's studies,† we must mention the varieties of Japanese apples, pears, peaches, plums, cherries, and persimmons. The persimmons are already well known in some parts of our country under the name "kaki," and they will doubtless make rapid progress in popular favor.

The following are less familar: *Actinidia arguta* and *volubilis*, with delicious berries;

Stauntonia, an evergreen vine yielding a palatable fruit;

Myrica rubra, a small tree with an acidulous, juicy fruit;

Elæagnus umbellata, with berries for preserves.

The active and discriminating horticultural journals in America and Europe are alive to the possibilities of new Japanese fruits,

* American Garden, New York. 1890–'91. † Ibid. 1891.

and it can not be very long before our list is considerably increased.

It is absolutely necessary to recollect that in most cases variations are slight. Dr. Masters and Mr. Darwin have called attention to this and have adduced many illustrations, all of which show the necessity of extreme patience and caution. The general student curious in such matters can have hardly any task more instructive than the detection of the variations in such common plants as the blueberry, the wild cherry, or the like. It is an excellent preparation for a practical study of the variations in our wild fruits suitable for selection.

It was held by the late Dr. Gray that the variations in Nature by which species have been evolved were led along useful lines—a view which Mr. Darwin regretted he could not entertain. However this may be, all acknowledge that by the hand of the cultivator variations can be led along useful lines; and, furthermore, the hand which selects must uphold them in their unequal strife. In other words, it is one thing to select a variety and another to assist it in maintaining its hold upon existence. Without the constant help of the cultivator who selects the useful variety, there comes a reversion to the ordinary specific type which is fitted to cope with its surroundings.

I think you can agree with me that the prospect for new fruits and for improvements in our established favorites is fairly good.

IV. Timbers and Cabinet Woods.—Can we look for new timbers and cabinet woods? Comparatively few of those in common use are of recent introduction. Attempts have been made to bring into great prominence some of the excellent trees of India and Australia which furnish wood of much beauty and timber of the best quality. A large proportion of all the timbers of the South Seas are characterized by remarkable firmness of texture and high specific gravity.* The same is noticed in many of the woods of the Indies. A few of the heavier and denser sorts, like jarrah, of West Australia, and sabicu, of the Caribbean Islands, have met with deserved favor in England, but the cost of transportation militates against them. It is a fair question whether in certain parts of our country these trees and others which can be utilized for veneers may not be cultivated to advantage. Attention should be again called to the fact that many plants succeed far better in localities which are remote from their origin, but where they find conditions substantially like those which they have left. This fact, to which we must again refer in detail with regard to certain other classes of plants, may have some bear-

* Useful Native Plants of Australia. By J. H. Maiden, Sydney.

ing upon the introduction of new timber trees. Certain drawbacks exist with regard to the timber of some of the more rapidly growing hard-wood trees which have prevented their taking a high place in the scale of values in mechanical engineering.

One of the most useful soft-wooded trees in the world is the kauri. It is restricted in its range to a comparatively small area in the North Island of New Zealand. It is now being cut down with a recklessness which is as prodigal and shameful as that which has marked our own treatment of forests here. It should be said, however, that this destruction is under protest; in spite of which it would seem to be a question of only a few years when the great kauri groves of New Zealand will be a thing of the past. Our energetic Forest Department has on its hands problems just like this which perplexes one of the new lands of the South. The task in both cases is double: to preserve the old treasures and to bring in new.

The energy shown by Baron von Mueller, the renowned Government Botanist of Victoria, and by various forest departments in encouraging the cultivation of timber trees will assuredly meet with success; one can hardly hope that this success will appear fully demonstrated in the lifetime of those now living, but I can not think that many years will pass before the promoters of such enterprises may take fresh courage.

In a modest structure in the city of Sydney, New South Wales, Mr. Maiden * has brought together, under great difficulties, a large collection of the useful products of the vegetable kingdom as represented in Australia. It is impossible to look at the collection of woods in that museum, or at the similar and more showy one in Kew, without believing that the field of forest culture must receive rich material from the southern hemisphere.

Before leaving this part of our subject it may be well to take some illustrations in passing, to show how important is the influence exerted upon the utilization of vegetable products by causes which may at first strike one as being rather remote.

1. Photography makes use of the effect of light on chromatized gelatin to produce under a negative the basis of relief plates for engraving. The degree of excellence reached in modifications of this simple device has distinctly threatened the very existence of wood-engraving, and hence follows a diminished degree of interest in box-wood and its substitutes.

2. Iron, and in its turn steel, is used in ship-building, and this renders of greatly diminished interest all questions which concern the choice of the different oaks and similar woods.

3. But, on the other hand, there is increased activity in certain

* Useful Native Plants of Australia. By J. H. Maiden, Sydney.

directions, best illustrated by the extraordinary development of the chemical methods for manufacturing wood-pulp. By the improved processes, strong fibers suitable for fine felting on the screen and fit for the best grades of certain lines of paper are given to us from rather inferior sorts of wood. He would be a rash prophet who should venture to predict what will be the future of this wonderful industry, but it is plain that the time is not far distant when acres now worthless may be covered by trees under cultivation growing for the pulp-maker.

There is no department of economic botany more promising in immediate results than that of arboriculture.

V. Vegetable Fibers.—The vegetable fibers known to commerce are either plant-hairs, of which we take cotton as the type, or filaments of bast-tissue, represented by flax. No new plant-hairs have been suggested which can compete in any way for spinning with those yielded by the species of *Gossypium*, or cotton, but experiments more or less systematic and thorough are being carried on with regard to the improvement of the varieties of the species. Plant-hairs for the stuffing of cushions and pillows need not be referred to in connection with this subject.

Countless sorts of plants have been suggested as sources of good bast-fibers for spinning and for cordage, and many of these make capital substitutes for those already in the factories. But the questions of cheapness of production, and of subsequent preparation for use, have thus far militated against success. There may be much difference between the profits promised by a laboratory experiment and those resulting from the same process conducted on a commercial scale. The existence of such differences has been the rock on which many enterprises seeking to introduce new fibers have been wrecked.

In dismissing this portion of our subject it may be said that a process for separating fine fibers from undesirable structural elements, and from resin-like substances which accompany them, is a great desideratum. If this were supplied, many new species would assume great prominence at once.

VI. Tanning Materials.—What new tanning materials can be confidently sought for? In his Useful Native Plants of Australia, Mr. Maiden * describes over thirty species of "wattles" or *Acacias*, and about half as many *Eucalypts*, which have been examined for the amount of tanning material contained in the bark. In all, eighty-seven Australian species have been under examination. Besides this, much has been done looking in the same direction at the suggestion and under the direction of Baron von Mueller, of Victoria. This serves to indicate how great is the

* Useful Native Plants of Australia. By C. H. Maiden, Sydney.

interest in this subject, and how wide is the field in our own country for the introduction of new tanning plants.

It seems highly probable, however, that artificial tanning substances will at no distant day replace the crude matters now employed.

VII. Resins, etc.—Resins, oils, gums, and medicines from the vegetable kingdom would next engage our attention if they did not seem rather too technical for this occasion, and to possess an interest on the whole somewhat too limited. But an allied substance may serve to represent this class of products and indicate the drift of present research.

*India Rubber.**—Under this term are included numerous substances which possess a physical and chemical resemblance to each other. An Indian *Ficus*, the early source of supply, soon became inadequate to furnish the quantity used in the arts even when the manipulation of rubber was almost unknown. Later, supplies came from *Hevea* of Brazil, generally known as Para rubber, and from *Castilloa*, sometimes called Central American rubber, and from *Manihot Glaziovii*, Ceara rubber. Not only are these plants now successfully cultivated in experimental gardens in the tropics, but many other rubber-yielding species have been added to the list. The *Landolphias* are among the most promising of the whole: these are the African rubbers. Now, in addition to these, which are the chief source of supply, we have *Willughbeia*, from the Malayan Peninsula, *Leuconotis*, *Chilocarpus*, *Alstonia*, *Forsteronia*, and a species of a genus formerly known as *Urostigma*, but now united with *Ficus*. These names, which have little significance as they are here pronounced in passing, are given now merely to impress upon our minds the fact that the sources of a single commercial article may be exceedingly diverse. Under these circumstances search is being made not only for the best varieties of these species but for new species as well.

There are few excursions in the tropics which possess greater interest to a botanist who cares for the industrial aspects of plants than the walks through the garden at Buitenzorg in Java and at Singapore. At both these stations the experimental gardens lie at some distance from the great gardens which the tourist is expected to visit, but the exertion well repays him for all discomfort. Under the almost vertical rays of the sun are here gathered the rubber-yielding plants from different countries, all growing under conditions favorable for decisions as to their relative value. At Buitenzorg a well-equipped laboratory stands ready to answer practical questions as to quality and composition of their products, and year by year the search extends.

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* See note (*), p. 71.

I mention this not as an isolated example of what is being accomplished in commercial botany, but as a fair illustration of the thoroughness with which the problems are being attacked. It should be further stated that at the garden in question assiduous students of the subject are eagerly welcomed and are provided with all needed appliances for carrying on technical, chemical, and pharmaceutical investigations. Therefore I am justified in saying that there is every reason for believing that in the very near future new sources of our most important products will be opened up, and new areas placed under successful cultivation.

At this point attention must be called to a very modest and convenient hand-book on the Commercial Botany of the Nineteenth Century, by Mr. Jackson, of the Botanical Museum attached to the Royal Gardens, Kew, which not only embodies a great amount of well-arranged information relative to the new useful plants, but is, at the same time, a record of the existing state of things in all these departments of activity.

VIII. Fragrant Plants.—Another illustration of our subject might be drawn from a class of plants which repays close study from a biological point of view, namely, those which yield perfumes.

In speaking of the future of our fragrant plants we must distinguish between those of commercial value and those of purely horticultural interest. The former will be less and less cultivated in proportion as synthetic chemistry by its manufacture of perfumes replaces the natural by the artificial products, for example, coumarin, vanillin, nerolin, heliotropin, and even oil of wintergreen.

But do not understand me as intimating that chemistry can ever furnish substitutes for living fragrant plants. Our gardens will always be sweetened by them, and the possibilities in this direction will continue to extend both by contributions from abroad and by improvement in our present cultivated varieties. Among the foreign acquisitions are the fragrant species of *Andropogon*. Who would suspect that the tropical relatives of our sand-loving grasses are of high commercial value as sources of perfumery oils?

The utility to the plant of fragrance in the flower, and the relation of this to cross-fertilization, are apparent to even a casual observer. But the fragrance of an aromatic leaf does not always give us the reason for its being.

It has been suggested for certain cases that the volatile oils escaping from the plants in question may, by absorption, exert a direct influence in mitigating the fierceness of action of the sun's rays. Other explanations have also been made, some of which are even more fanciful than the last.

When, however, one has seen that the aromatic plants of Australia are almost free from attacks of insects and fungi, and has learned to look on the impregnating substances in some cases as protective against predatory insects and small foes of all kinds, and in others as fungicidal, he is tempted to ask whether all the substances of marked odor which we find in certain groups of plants may not play a similar *rôle*.

It is a fact of great interest to the surgeon that in many plants there is associated with the fragrant principle a marked antiseptic or fungicidal quality; conspicuous examples of this are afforded by species of *eucalyptus*, yielding eucalyptol; *Styrax*, yielding styrone; *Thymus*, yielding thymol. It is interesting to note, too, that some of these most modern antiseptics were important constituents in the balsamic vulneraries of the earliest surgery.

Florists' plants and the floral fashions of the future constitute an engaging subject which we can touch only lightly. It is reasonably clear that while the old favorite species will hold their ground in the guise of improved varieties, the new introductions will come in the shape of plants with flowering branches which retain their blossoms for a somewhat long period, and especially those in which the flowers precede the leaves. In short, the next real fashion in our gardens is probably to be the flowering shrub and flowering tree, like those which are such favorites in the country from which the Western world has gladly taken the gift of the chrysanthemum.

Twice each year, of late, a reception has been held by the Emperor and Empress of Japan. The receptions are in autumn and in the spring. That in the autumn, popularly known as the Emperor's reception, has for its floral decorations the myriad forms of the national flower, the chrysanthemum; that which is given in spring, the Empress's reception, comes when the cherry blossoms are at their best. One has little idea of the wealth of beauty in masses of flowering shrubs and trees until he has seen the floral displays in the Imperial Gardens and the Temple grounds in Tokio.

To Japan* and China also we are indebted for many of the choicest plants of our gardens, but the supply of species is by no means exhausted. By far the larger number of the desirable plants have already found their way into the hands of cultivators, but often under conditions which have restricted their dissemination through the flower-loving community. There are many which ought to be widely known, especially the fascinating dwarf

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* The Flowers of Japan and the Art of Floral Arrangement. By Josiah Conder, F. R. I. B. A., Architect to the Imperial Japanese Government. Yokohama, 1891. See also two other works by the same author: Theory of Japanese Flower Arrangements, and Art of Landscape Gardening in Japan. (1886.)

shrubs and dwarf trees of the far East, which are sure to find sooner or later a warm welcome among us.

X. Forage Plants.—Next to the food-plants for man, there is no single class of commercial plants of greater interest than the food-plants for flocks and herds. Forage plants, wild and cultivated, are among the most important and highly valued resources of vast areas. No single question is of more vital consequence to our farthest West and Southwest.

It so happens that the plants on which the pastoralist relies grow or are grown on soil of inferior value to the agriculturist. Even soil which is almost sterile may possess vegetation on which flocks and herds may graze; and, further, these animals may thrive in districts where the vegetation appears at first sight too scanty or too forbidding even to support life. There are immense districts in parts of the Australian continent where flocks are kept on plants so dry and desert-like that an inexperienced person would pass them by as not fit for his sheep, and yet, as Mr. Samuel Dixon* has well shown, these plants are of high nutritive value and are attractive to flocks.

Relegating to the notes to be published with this address brief descriptions of a few of the fodder-plants suggested for use in dry districts, I shall now mention the salt-bushes of various sorts, and the allied desert plants of Australia, as worth a careful trial on some of our very dry regions in the farthest West. There are numerous other excellent fodder-plants adapted to dry but not parched areas which can be brought in from the corresponding districts of the southern hemisphere and from the East.

At an earlier stage of this address I have had occasion to refer to Baron von Mueller, whose efforts looking toward the intro-

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* Mr. Samuel Dixon's list is in vol. viii (for 1884–'85) of the Transactions and Proceedings and Report of the Royal Society of South Australia. Adelaide, G. Robertson, 1886. *Bursaria spinosa:* "A good stand-by," after the grasses dry up. *Pomaderris racemosa,* "stands stocking well." *Pittosporum phyllaeroides:* "Sheep exceedingly partial to its foliage." *Casuarina quadrivalvis:* "Tenderness of fiber of wool would be prevented by it in our finer wool districts." *Acacias,* the wattles: "Value as an astringent, very great," being curative of a malady often caused by eating frozen grass. *Acacia aneura* (mulga): "Must be very nutritious to all animals eating it." This is the plant which is such a terror to the stockmen who have to ride through the "scrub." *Cassia,* some of the species with good pods and leaves for sheep. The foregoing are found in districts which are not wholly arid. The following are, more properly, "dry" plants. *Sida petrophila:* "As much liked by sheep as by marsupials." *Dodonæa viscosa,* native hop-bush: "Likes warm, red, sandy ground." *Lycium australe:* "Drought never seems to affect it." *Kochia aphylla:* "All kinds of stock are often largely dependent on it during protracted droughts." *Rhagodia parabolica:* "Produces a good deal of foliage." *Atriplex vesicaria:* "Can be readily grown wherever the climate is not too wet." I have transferred only those which Mr. Dixon thinks most worthy of trial. Compare also Dr. Vasey's valuable studies of the plants of our dry lands, especially grasses and forage plants (1878), grasses of the arid districts of Kansas, Nebraska, and Colorado (1886), grasses of the South (1887).

duction of useful plants into Australasia have been aided largely by his convenient treatise on economic plants.* It may be said in connection with the fodder-plants, especially, that much which the baron has written can be applied *mutatis mutandis* to parts of our own country.

The important subject of introducing fodder-plants has been purposely reserved to the last because it permits us to examine a practical point of great interest. This is the caution which it is thought necessary to exercise when a species is transferred by our own choice from one country to another. I say by our choice, for, whether we wish it or not, certain plants will introduce themselves. In these days of frequent and intimate intercommunication between different countries, the exclusion of foreign plants is simply impossible. Our common weeds are striking illustrations of the readiness with which plants of one country make for themselves a home in another.† All but two of the prominent weeds of the Eastern States are foreign intruders.

There are all grades of persistence in these immigrants. Near the ballast grounds of every harbor, or the fields close by woolen and paper mills where foreign stock is used, you will observe many foreign plants which have been introduced by seed. For many of these you will search in vain a second year. A few others persist for a year or two longer, but with uncertain tenure of the land which they have invaded; others still have come to stay. But happily some of the intruders, which seem at first to gain a firm foothold, lose their ground after a while. We have a conspicuous example of this in a hawkweed, which was very threatening in New England two years ago, but is now relaxing its hold.

Another illustration is afforded by a water-plant which we have given to the Old World. This plant, called in our botanies *Anacharis*, or *Elodea*, is, so far as I am aware, not troublesome in our ponds and water-ways, but when it was carried to England, perhaps as a plant for the aquarium, it was thrown into streams and rivers with a free hand. It spread with remarkable rapidity and became such an unmitigated nuisance that it was called a curse. Efforts to extirpate it merely increased its rate of growth. Its days of mischief are, however, nearly over, or seem to be drawing to a close; at least so Mr. Lynch, of the Botanic Garden in Cambridge, England, and others of my informants think. The history of the plant shows that even under conditions which, so

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* See note, p. 59.

† The weeds of German gardens and agricultural lands are mostly from Mediterranean regions, but the invasions in the nncultivated districts are chiefly from America (snch as *Œnothera*, *Mimulus*, *Rudbeckia*). *Handbuch der Pflanzengeographie*, von Dr. Oscar Drude (Stuttgart), 1890, p. 97.

far as we can see, are identical with those under which the plant grew in its home, it may for a time take a fresh lease of life and thrive with an undreamed-of energy.

What did *Anacharis* find in the waters of England and the Continent that it did not have at home, and why should its energy begin to wane now?

In Australasia one of the most striking of these intruders is sweet-brier. Introduced as a hedge plant, it has run over certain lands like a weed, and disputes every acre of some arable plats. From the facility with which it is propagated it is almost ineradicable. There is something astounding in the manner in which it gains and holds its ground. Gorse and brambles and thistles are troublesome in some localities, and they prove much less easy to control than in Europe. The effect produced on the mind of the colonist by these intruding pests is everywhere the same. Whenever, in an examination of the plants likely to be worthy of trial in our American dry lands, the subject was mentioned by me to Australians, I was always enjoined to be cautious as to what plants I might suggest for introduction from their country into our own. My good friends insisted that it was bad enough to have as pests the plants which come in without our planning or choice, and this caution seems to me one which should not be forgotten.

It would take us too far from our path to inquire what can be the possible reasons for such increase of vigor and fertility in plants which are transferred to a new home. We should have to examine all the suggestions which have been made, such as fresh soil, new skies, more efficient animal friends, or less destructive enemies. We should be obliged also to see whether the possible wearing out of the energy of some of these plants after a time might not be attributable to the decadence of vigor through uninterrupted bud-propagation, and we should have to allude to many other questions allied to these. But for this time fails.

Lack of time also renders it impossible to deal with the questions which attach themselves to our main question, especially as to the limits of effect which cultivation may produce. We can not touch the problem of inheritance of acquired peculiarities, or the manner in which cultivation predisposes the plant to innumerable modifications. Two of these modifications may be mentioned in passing, because they serve to exemplify the practical character of our subject.

Cultivation brings about in plants very curious morphological changes. For example, in the case of a well-known vegetable the number of metamorphosed type-leaves forming the ovary is two, and yet under cultivation the number increases irregularly until the full number of units in the type of the flower is reached.

Prof. Bailey, of Cornell, has called attention to some further interesting changes in the tomato, but the one mentioned suffices to illustrate the direction of variation which plants under cultivation are apt to take. Monstrosities are very apt to occur in cultivated plants, and under certain conditions may be perpetuated in succeeding generations, thus widening the field from which utilizable plants may be taken.

Another case of change produced by cultivation is likewise as yet wholly unexplained, although much studied, namely, the mutual interaction of scion and stock in grafting, budding, and the like. It is probable that a further investigation of this subject may yet throw light on new possibilities in plants.

We have now arrived at the most practical question of all, namely—

In what way can the range of commercial botany be extended? In what manner or by what means can the introduction of new species be hastened?

It is possible that some of you are unaware of the great amount of uncoördinated work which has been done and is now in hand in the direction of bringing in new plants.

The competition between the importers of new plants is so great both in the Old World and the New that a very large proportion of the species which would naturally commend themselves for the use of florists, for the adornment of greenhouses, or for commercial ends, have been at one time or another brought before the public or are being accumulated in stock. The same is true, although to a less extent, with regard to useful vegetables and fruit. Hardly one of those which we can suggest as desirable for trial has not already been investigated in Europe or this country, and reported on. The pages of our chemical, pharmaceutical, medical, horticultural, agricultural, and trade journals, especially those of high grade, contain a wealth of material of this character.*

But what is needed is this, that the promising plants should be systematically investigated under exhaustive conditions. It is not enough that an enthusiast here, or an amateur there, should give a plant a trial under imperfectly understood conditions, and then report success or failure. The work should be thorough and every question answered categorically, so that we might be placed in possession of all the facts relative to the object experimented upon. But such an undertaking requires the co-operation of many different agencies. I shall venture to mention some of these.

In the first place—botanic gardens amply endowed for re-

* The list of economic plants published by the department in Washington is remarkably full, and is in every way creditable to those in charge.

search. The Arnold Arboretum, the Shaw Garden, and the Washington Experimental Garden are American illustrations of what is needed for this purpose. University gardens have their place in instruction, but can not wisely undertake this kind of work.

In the second place—museums and laboratories of economic botany. Much good work in this direction has been done in this country by the National Museum and by the department in charge of the investigation of new plants. We need institutions like those at Kew in England, and at Buitenzorg in Java, which keep in close touch with all the world. The founding of an establishment on a scale of magnitude commensurate with the greatness and needs of our country is an undertaking which waits for some one of our wealthy men.

In the third place—experiment stations. These may, within the proper limits of their sphere of action, extend the study of plants beyond the established varieties to the species, and beyond the species to equivalent species in other genera. It is a matter of regret that so much of the energy displayed in these stations in this country, and we may say abroad, has not been more economically directed.

Great economy of energy must result from the recent change by which co-ordination of action is assured. The influence which the stations must exert on the welfare of our country and the development of its resources is incalculable.

In the last place, but by no means least, the co-operation of all who are interested in scientific matters, through their observation of isolated and associated phenomena connected with plants of supposed utility, and by the cultivation of such plants by private individuals, unconnected with any State, governmental, or academic institutions.

By these agencies, wisely directed and energetically employed, the domains of commercial and industrial botany will be enlarged. To some of the possible results in these domains I have endeavored to call your attention.

The stock of diamonds, according to the calculations of Iron, has increased enormously during the past fifteen years. The product of the African mines, 1,500,000 carats in 1876, was 4,000,000 carats in 1889. Still, the demand for diamonds increases, and the price rises every year. The traffic in diamonds is essentially different from all other trades in the single item that the product is never consumed. While there is a perceptible wear even in gold and silver, a diamond, once cut, is permanently added to the stock, and is liable to come upon the market at any time. Yet a place and eager purchasers are found for all the new ones.

THE LOST VOLCANOES OF CONNECTICUT.

By Prof. WILLIAM MORRIS DAVIS.

SEVERAL years ago, while walking down the lower Connecticut valley with a party of students, we chanced upon a curious ledge of rock surmounting a low ridge by the road that runs from Berlin to Meriden, about half-way between Hartford and New Haven. A scramble up the slope through a bushy growth of young trees led to the foot of the ledge—a thick bed of gray-greenish rock, not in layers like limestone or sandstone, not crystalline like granite or gneiss, but of a loose, structureless texture, here and there carrying roughly rounded blocks of a dense, dark rock which we knew to be an old lava, from its resemblance to the rocks ejected from modern volcanoes. Although a ledge of this kind is not of ordinary occurrence, its features were so well marked that there could be little doubt of its nature and origin; it was a bed of volcanic ashes, interspersed with blocks or bombs of lava that must have been thrown from some neighboring vent long ago in the ancient time when the rocks of the valley were made. The ash-bed lay upon a series of muddy sandstones that

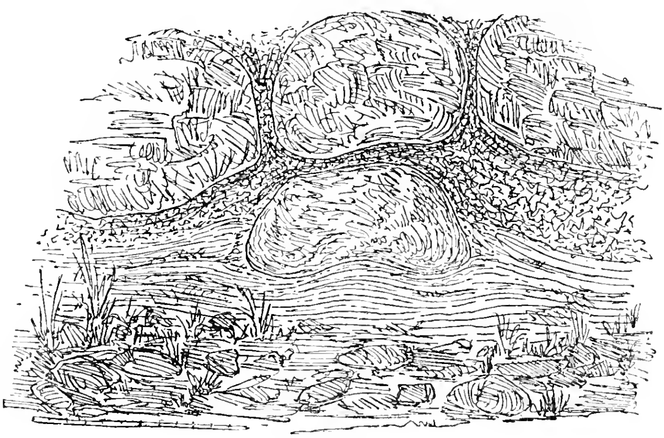


Fig. 1.

had evidently been formed under water, for they were deposited in layers, just as sand and mud are now when they are washed into a pond; and to all appearances the eruption of the ashes and bombs had taken place during the accumulation of the sandstones. The ashes had fallen into the water and settled down gently on the soft, sandy mud at the bottom; one of the dense lava blocks was seen to have indented itself in the sandy layers, bending them down on either side of it, just as if it had been an early product of

the eruption, arriving here before the ashes, plunging down after its lofty flight through the air, and sinking into the mud at the bottom of the water. In this it recalls the reptilian footprints that have made the sandstones of the valley famous. The old reptiles walked over the mud-flats and left their heavy prints on the surface to be buried under the next layer of mud; the lava block fell into the soft sandy mud and made its print, where it still lies. Long may it rest undisturbed! A poor indication of it is presented in Fig. 1, copied from a photograph by a friend in New Britain, Conn. All this was much more evident and more easily interpreted than those who try to learn geology from books are disposed to believe. Indeed, one of the students with me exclaimed: "This is the most realistic thing I ever saw; I had no idea that it could be so plainly made out." The ledge has been visited by hundreds of persons from Meriden and the surrounding towns, and a well-beaten path now leads up to it from the road. I have taken parties of students there every summer since then, and hope to do my share toward beating down that path for many years to come. But although the meaning of the ash-bed is plain enough, there is a question suggested by it that is not so easily answered. Where is the volcano from which the ashes and bombs were blown out?

The same question has arisen in other countries. For example, in central France, in Auvergne, there are chalky beds that were once a soft white mud, and in these lie bombs of lava, bending down the layers on either side; manifestly again the result of a bombardment from some adjacent volcano. In the same district there are beds of ashes and flows of lava, all indicating volcanic outbursts in their vicinity; but when the question is there asked—Where are the volcanoes from which these products came?—it is easily answered, for many volcanic cones still stand up in plain sight near by; the lava-flows may be traced up to their bases, the craters are still visible at the summits, and although no record exists of their eruptions, it is manifest that at a relatively recent prehistoric period these cones exhibited a brisk activity. I walked over them a dozen years ago; they make a delightful strolling and sketching ground, and I remember well lunching with a shepherd on one of their sunny slopes, and answering his questions about distant America (Fig. 2).

We may look in vain for volcanic cones in the neighborhood of our Meriden ash-bed bluff. There are hills and ridges all around, but nowhere can we see the smooth and characteristic concave slopes of a volcanic cone. To the south, there are several symmetrically rounded hills, but they are convex, not concave, on the side, and an examination of the road-cuts made in their slopes shows them to be of anything but volcanic origin. They are "drumlins," hills

of rubbish that were left there and given their even form when the whole of New England was buried in a deep sheet of moving ice, as Greenland is now (Fig. 3). They give no clew to the source of the bombs and ashes. If we go west or east of the ash-bed ledge, there are high ridges, six or seven hundred feet above the valley, with gentle slopes on the east, and bold, rocky cliffs, descending to a long stony talus on the west. The one next east of us is Mount Lamentation; it may be well seen eastward from the railroad between Hartford and Meriden while the train is passing a pond. The ash-bed ledge can be seen at the same time under the southern end of Lamentation, but it is not a conspicuous object a mile away. Lamentation and its fellows are not the least like volcanoes, and yet they confirm the belief that volcanoes must have once existed hereabouts; for these high ridges are of lava, the edges of great tilted lava-flows that were poured out at intervals during the deposition of hundreds and thousands of feet of sandstones.

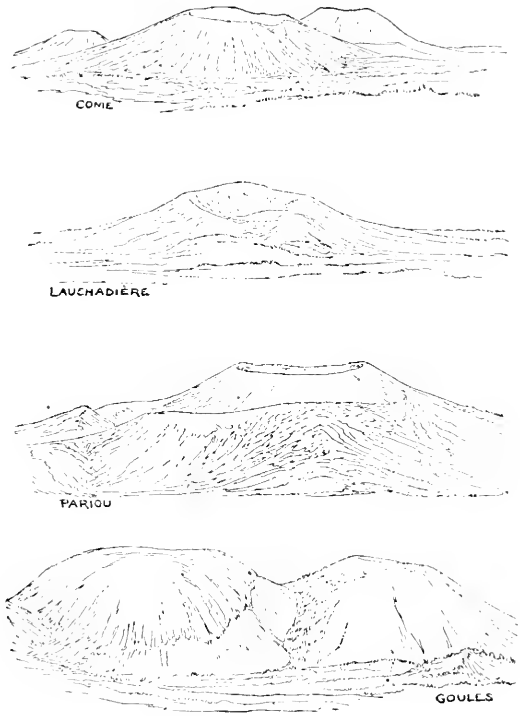


Fig. 2.

Our ash-bluff is indeed only a part of one of these parallel lava-ridges; when traced north and south lava may be found lying on the ash-bed. Lamentation is higher, because its lava-flow is much thicker than that in the ash-bed ridge, and therefore has not been worn down so low. On the back of these flows, at one point and another, may be seen the slaggy, bubbly surface of the lava, like that poured out of Vesuvius or any other modern volcano; but these ancient lavas have been deeply buried in

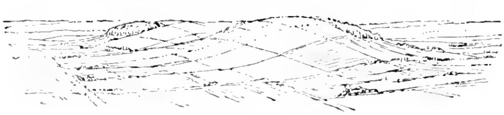


Fig. 3.

sands and muds, and tilted up and worn down, during the evolution of their present form. There is a quarry at Meriden where one lava-sheet may be seen lying directly upon the scoriaceous, ropy surface of an older one. Evidently, the region has witnessed volcanic action, as the ash-bed implied. Perhaps we fail to recognize the cone at the point of outburst because it has been partly worn away. There are many volcanic regions where the eruptive action is not so recent as in Auvergne, and where the cones are consequently somewhat out of repair; deep gulleys furrow their sides and destroy their symmetrical form. Something of this may, indeed, be seen in Auvergne, for the volcanoes there are not all of the same age. Some are sadly wasted, and are recognized as volcanoes only because their remnants of lava-flows and ash-beds all slope away from a central lava-mass, which marks the place of the vent. It is chiefly in this way that the Madeira Islands differ from the Azores; the latter possess many cones of regular form, but the older volcanoes on the former are deeply dissected; so much so that it is difficult to reconstruct the original cones from which the present rugged hills and ridges have been carved out. The same contrast may be seen on a grand scale in the Hawaiian Islands, as described by Dana. The most southeastern of the group is the most recent. It is the largest, and is in the best repair; not a volcanic cone of the usual steep-sided form, indeed, but of long, smooth, gentle slopes, because its lavas were too liquid when erupted to stand on steep slopes such as are formed by heaps of ashes and cinders. Other islands farther to the northwest in the same group are mere wrecks; their edges are cut off by the waves, forming great sea-cliffs, their slopes are scored by deep ravines and cañons, and their once even profiles are replaced now by sharply notched outlines. Yet nothing of even those angular forms is to be found about Meriden. If the absence of the cone from which the ashes came is due to wearing away, it must truly have been worn out.

There is, however, another method of disposing of volcanoes that has been practiced in Italy. The cone has either been blown to pieces and scattered by violent eruptions, or has been allowed to sink down by the withdrawal of lava from beneath its foundations. In either case, a great basin, often holding a lake, marks the site of the lost cone. There are several lakes of this kind in Italy—Trasimeno, Bolsena, Bracciano, and others; Sumatra possesses some huge basins of the same pattern; but there are no such basins in Connecticut. There are no lakes at all near Meriden, and the lakes in the back country are only old valleys obstructed by glacial drift.

There is an account of an old volcanic region out in New Mexico that may, perhaps, guide our search. In the district of the

Zuñi plateaus, Dutton describes numerous relatively small isolated buttes or sharply conical hills, steeper sided than volcanic cones, of a different profile, and without the crater at the top. They consist of dense lava, not in layers spread out from a central vent upon the surrounding surface, but in a solid mass with columnar structure; and at their bases it is sometimes possible to see that they are inclosed on all sides by the country rock. It is believed that these buttes are nothing more than lava-plugs, frozen solid in the pipes up through which the lava rose at the time of eruption from its deep source to the surface where it overflowed; but that the time of eruption is so long ago that the cones and all the surface outpourings are worn away, and only the stumps of the plugs remain to tell the tale. Fig. 6 attempts to show the early and late forms, one below the other. Structures of the same kind are known in the Black Hills, in Scotland, and elsewhere. Perhaps this hint will help us in understanding Connecticut.

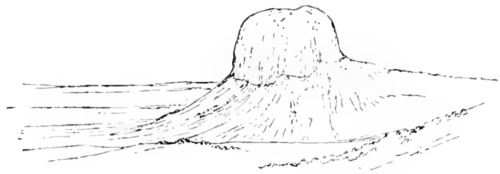


Fig. 4.

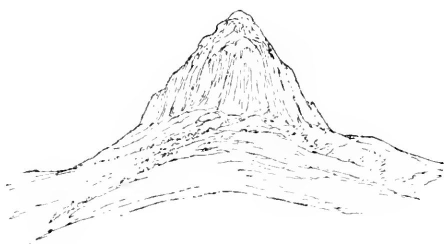


Fig. 5.

There is one thing about the ash-bed and lava-sheets in Connecticut that is certainly favorable to the suggestion given by the Zuñi buttes. The lava-sheets are not now level, as they undoubtedly were when they were poured out: but all the series of sandstones, ash-beds, lava-sheets, and the rest have been lifted up together on the western side of the valley, so that they slant down or dip to the eastward at a moderate angle. Standing on the bluff of the ash-bed, it is easy to trace its edge north and south, and to perceive that it is continued slanting underground on the east, and to imagine that it was once continued upward into the air on the west; for on this side the uplifting exposed it to the patient, persistent attack of the weather, by which in the course of ages it may have been greatly worn away. In the same way, other lava-ridges in the neighborhood, such as Mount Lamentation and the beautiful Hanging Hills, are simply the worn edges of lava-sheets that still plunge underground eastward, and that once rose high into the air westward.

It follows from this new understanding that if the vent, from which the ashes were blown and the lavas poured, lay to the east

of the ash-bed ridge, it must be still underground and not discoverable at present. It may be revealed to distant future ages, but to us it is buried. But if the vent lay to the west of the ridge, it may be discovered, not as the cone for which we looked at first, but as a pipe or neck of lava. Indeed, it must in this case be discoverable, for the lava and ashes must somewhere have risen from a deep subterranean reservoir, through the country rocks, up to the surface; and if their point of escape lie west of the ash-bed ridge, it must be in sight somewhere. We may not now hope to find the cone where the lavas rose and burst out through the body of water in which the muddy sandstones were accumulating; we can not now hope to discover the crater from which the ashes and bombs were scattered far and wide, and from whose flanks the lava-floods were poured over the low grounds around about it; but we may hope to find a knob or hill where the lava-pipe has been worn down to an undetermined depth beneath the surface on which its cone was built.

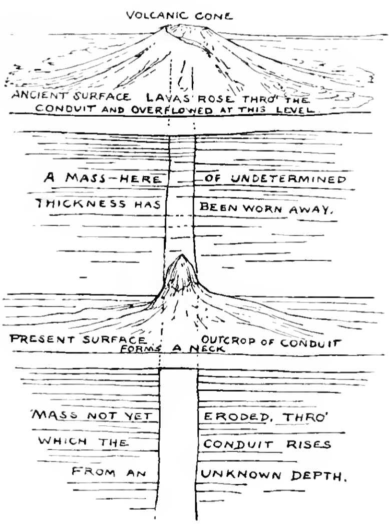


Fig. 6.

This seems to be the fact. Some ten miles southwest of Meriden lie the rugged Blue Hills, one of which is known as Mount Carmel. These may be seen to the west of Wallingford, on the railroad between New Haven and Hartford, or east of Mount Carmel station on the New Haven and Northampton Railroad. They consist of a network of thick necks and dikes of lava; not of loose texture like the ashes, not slaggy like the backs of the lava-sheets, but dense and solid, as if they had been driven there under great pressure. Mount Carmel and its fellows have not the simple outline of the Zuñi buttes; they are of irregular form, corresponding to their complicated structure, as if a compound fracture had been opened to give passage to the ascending lavas, or as if repeated eruptions had forced their way surfaceward at this point, every one increasing the size and complexity of the lava pipes and cracks. There is no other vent of the kind to be found so near to the ash-bed and lava ridges of the Meriden district as Mount Carmel; and while it is entirely possible that a vent may exist at a less distance on the east, concealed beneath the overlying strata in that direction, it is at least permissible

and plausible to regard Mount Carmel and the Blue Hills as the source of the ashes and bombs and lava-sheets over by Meriden and up and down the valley.

The Blue Hills have rough slopes to climb, but the view from their tops and the suggestion of past history that one gains there pay for the labor of the scramble. It is easily understood that the rocks are lavas and that they have ascended through the surrounding rocks from some deep source. It is manifest that they did not rise from below when the surface of the country had its present form, for in that case they must have flowed down into the low lands on all sides, and they must have had the slaggy and scoriaceous texture characteristic of surface lavas. One can not doubt that when the lavas of the Blue Hills were placed in their present relation to their surroundings they were deep underground, inclosed by rocky walls on all sides, and heavily pressed upon by the mass above. They forced their way upward from some deep reservoir of molten lava because the push upon them was even greater than the heavy resistance from above. They reached the surface at last, hundreds or thousands of feet above the present summit of the Blue Hills, and there burst out in true volcanic eruption, forming a conical island in the great estuary in which the valley sandstones were formed. We can hardly suppose that they built a grand cone, like Fujiyama, in Japan, twelve thousand feet above sea-level; perhaps they only formed a small mound, like the little temporary volcanic island that appeared in the middle Mediterranean in 1831, called Graham Island, Isle Julia, and Nerita, by its various discoverers. But the Blue Hills were undoubtedly in eruption more than once. This may be safely inferred from the complex network of their pipes and dikes, as well as from the repeated occurrence of lava flows among the series of bedded rocks in the Meriden district. In this respect, as in others, the Blue Hills were like volcanoes of our times. Some of their outpourings were more plentiful than others. Mount Lamentation is part of a lava-sheet whose thickness must be from three to four hundred feet, and whose total original area must have been at least two or three hundred square miles. But the other sheets are not so massive as this one; they indicate eruptions of less energy. While the eruptions were going on there must have been a great scurrying about of the old reptiles whose tracks are found on the sandstone beds at various points in the valley: perhaps the patient searcher may some day find one of their skeletons buried under the ashes of an eruption, just as the old Pompeians have been found buried under the mud and ashes from the outburst of Vesuvius that destroyed their city. During the intervals of rest between the eruptions a luxuriant growth of tree-ferns may have clothed the

slopes of the volcanic island, for leaves of cycads are found in the neighboring beds of shales. And yet all this is gone. The volcanoes are only things of the imagination. The Blue Hills mark the conduits through which they were fed with lavas, but the cones are lost in the empty air above; only the deep roots of the structure are now preserved for us.

Perhaps the accompanying diagrams may aid the reader in gaining a fuller understanding of the geological history of the region. They are drawn from a wooden model that was prepared for exhibition before the Geological Society of America at its last winter meeting in Washington. The first (Fig. 7) represents a block of the Triassic formation, lying horizontally on its deep crystalline foundation, the whole representing a cube of about ten miles on a side, and hence showing a hundred square miles of upper surface. The oblique lines across the top need not be considered for the present. The horizontal lines around the sides near the top are the interbedded lava-sheets, and all these, with the sandstones and shales, lie on the upturned eroded edges of the foundation of old crystalline rocks. The bedded rocks were spread out in the old sinking estuary in deposits of great volume, aggregating ten or twelve thousand feet in thickness at least, but always in shallow water, for they frequently show cross-bedding and ripple marks, and sometimes mud-cracks and rain-drops, and occasionally even foot-prints of various kinds. The famous Hitchcock collection, in the Amherst College Museum, illustrates all these features in great variety. During the period of accumulation of the bedded rocks there were at least three epochs of considerable volcanic activity. About half of the total thickness of the strata had been deposited when the first outburst took place, and this is the one that yielded the ashes and bombs at Meriden. Its lava-flows spread many miles north and south, but gained only a moderate measure of thickness, generally not more than a hundred feet. These correspond to the bed marked A in Fig. 8, which represents a magnified view of a corner of the block seen

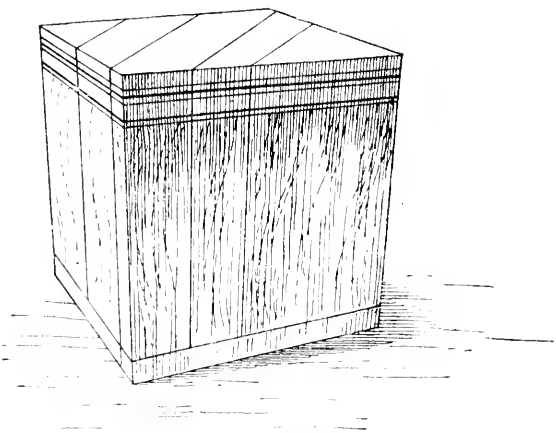


Fig. 7.

in Fig. 7. When this first volcanic disturbance was over, the accumulation of sandstones went on again, the sands were washed in from the shores of the estuary and crept out over the back of the lava-sheet; the finer sediments settled down into the irregular crevices in the surface of the flow, even filling little half-open vesicles. A microscopic examination of specimens from these contacts of lava and overlying sandstones brings back vividly the condition of their deposition. Loose fragments of the lava, carried a little way by the waves and more or less water-worn, were mixed with the sands for a few feet above the lava, but they were soon all buried. Then things went on for a long time about as before the eruption. The supply of sediments seems to have become finer after a while, for a bed of black shale is found, with numerous impressions of fossil fishes and plants, one of the few traceable fossiliferous layers of the entire formation. Then came more barren sandy shales again. It is impossible to measure the time of this quiet work in years, but after three or four hundred feet of strata had been formed, another outburst of lava (M) took place, and on a greater scale than the first. The lava-sheet formed by this eruption is three or four hundred feet thick—thick enough to have in all probability filled the shallow estuary wherever it ran, transforming it into a level lava plain, like the plain of the Shoshone River of to-day But the depression of the estuary trough continued; if the lava surface was at first above water level, it was soon submerged and buried in sands and mud, repeating all the significant phenomena of contact that have been mentioned above. Then came another long period of quiet, broken by a third lava outpouring (P); and after that, still more sandstones and shales, until aqueous and igneous rocks had accumulated to a thickness of perhaps two miles. At some time during this long history a sheet of lava was driven in or intruded between the sandstones near the bottom of the formation (marked I in Fig. 8);

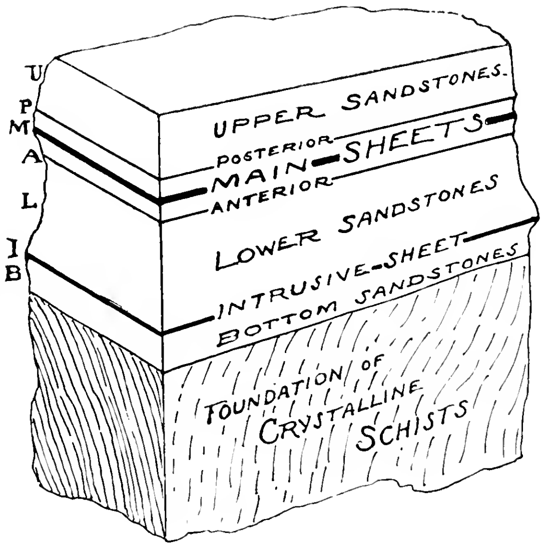


FIG. 8.

it is easily known to be an intrusion by the dense texture of its upper surface, and by the occasional branches that rise from it into the overlying beds, and by various other features in which it differs distinctly from the overflow sheets or extrusions. But it need not be further considered now.

In order to exhibit these relations of the igneous rocks to the stratified deposits in a clearer manner, the model is constructed so as to open on a diagonal section (as in Fig. 9), and disclose the

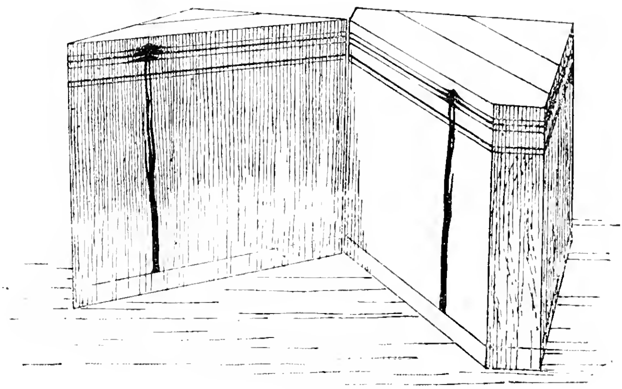


Fig. 9.

pipe or chimney up through which the lavas rose from their deep source. The volcanic cones, presumably formed at the surface where the chimney opened at the three times of eruption, are here placed in their proper positions in the series of stratified deposits; but even the topmost cone is supposed to have been entirely buried by gradual submergence and by the accumulation of sands and muds upon it. The intrusive sheet is shown near the bottom of the stratified series. The whole series may then be named as follows. First, a moderate thickness of bottom sandstones, often conglomeratic; then, the intrusive sheet; next, the great series of lower sandstones and shales, also sometimes conglomeratic; then, the three extrusive sheets, with their intervening sandstones and shales. The first of the extrusions will be called the anterior sheet, the middle one is the main sheet, the third is the postorior (for reasons that will appear more clearly further on), and they are separated by the anterior and posterior shales respectively. On the top of all come the upper sandstones and shales. The whole series is probably two miles thick, as already stated.

We may imagine in a general way that in time the estuary was filled with the detritus that was washed into it, and thus transformed into a lowland plain, like that of the Po, between the Alps and the Apennines; or like the plain of California, between the Sierra Nevada and the coast range. If it was not ultimately filled

up so as to form a land area, it was at least a subaqueous plain of very even and level surface. The deeper layers of the formation may have sagged a little toward the middle of the estuary on account of the progressive depression that the region had suffered during the accumulation of the entire mass, but their departure from horizontality was moderate. Yet at present the whole series, with but trifling exceptions, inclines at an angle of twelve, fifteen, or twenty degrees to the eastward. Evidently a serious disturbance has affected the original attitude of the beds.

The eastward slant or dip of the series might be imitated by tilting the model over bodily, so that its upper surface should be inclined to the east; but this fails to represent the dislocations by which the mass is known to be traversed. The model was therefore made in several parts, each of which could be tilted independently of its neighbors, as shown in Fig. 10, the observer looking southeast. It is here made clear that while the dip of the beds is to the eastward, the course of the fractures by which they are dislocated is northeastward; this relation prevailing in a very constant manner in the region of the Meriden ash-bed. The blocks into which the mass is thus divided, five of which are shown in the model, have been moved by moderate amounts on one another; the movement varies from a few feet up to two thousand. This is called faulting, and its effect in this case is manifestly to break up the continuous surface of the inclined plane that would have been formed by simple tilting, and produce a discontinuous surface, with steps from one part to another. If we may judge by the angle at which the beds lie, the elevated edges of these dislocated blocks must have once risen high into the air, producing mountainous ridges of no insignificant relief. Yet at present nothing of this ancient constructional form is apparent. The tilting and faulting were both done so long ago that no part of the original surface remains. It has all been worn away. The best evidence of the antiquity of the dislocations is found in another State.

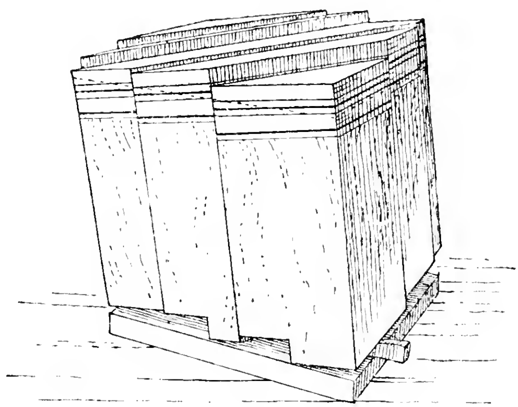


Fig. 10.

Down in New Jersey, the corresponding red sandstone forma-

tion is unconformably overlain by the Cretaceous strata of the coastal plain, proving that the sandstones were not only tilted but deeply eroded before the Cretaceous beds were laid upon them. The formations in New Jersey and Connecticut are so much alike that we may safely conclude that the period of dislocation was the same in both; hence we shall suppose that the Meriden sandstones and lava-sheets were tilted and faulted into the position illustrated in Fig. 10 during the interval between Triassic and Cretaceous time—that is, in the Jurassic period. From that time to now their history is concerned chiefly with the erosion by which their original constructional inclined planes have been reduced to their present surface of varied topography.

There is good reason to think that the history of the erosion is a double one, comprehending first a longer cycle, and second a shorter cycle of time. During the first cycle, the great relief of the uptilted beds was reduced to a lowland of denudation, a surface of a moderate relief close to the base-level of erosion, an almost plane surface, a "peneplain"—the evidence of this being found in the even uplands of the crystalline plateaus which now inclose the Triassic valley on the east and west. No explanation for the evenness of these plateaus can be found save the one which regards them as having been reduced from some greater mass by a long-continued process of erosion, at a time when the region stood somewhat lower than now — low enough to place the present plateau-like uplands close to sea-level; and the sandstones, shales, and lava-sheets between the two plateaus undoubtedly suffered the same denudation. This is indicated in Fig. 11, in which all the upper part of the model as shown in Fig. 10 has been removed; the obliquely beveled surface of the beds now represents the lowland of denudation, or peneplain, to which they were reduced. The effect of the oblique faulting is now rendered apparent by the dislocations in the belts of the different outcrops. The main sheet of lava, for example, is seen in each of the blocks into which the formation is divided by the faults; so is the belt of shales lying under it, and so on with every member of the series.

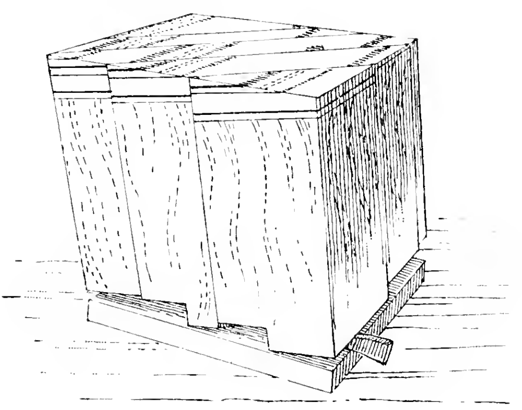


Fig. 11.

Indeed, the reader must perceive that it is only because the actual facts of observation are thus arranged that the existence of the faults is inferred. Most of the faults are of moderate displacement; but just north of Meriden there is one whose movement amounted to two thousand feet; it cuts off the northern end of the main lava-sheet in Lamentation and the southern end of the same in the Hanging Hills group of lava-ridges. In following along the line between these two dislocated portions of the sheet, every ridge formed by the more resistant sandstones or conglomerates is cut off in a most systematic manner, precisely according to the pattern shown in the beveled surface of the model. The railroad crosses this great fault about a mile above Meriden, but the traveler will see nothing there to indicate the dislocation; its constructional effects have all been worn out.

But the region is not now a plain. It is a rolling lowland with occasional ridges formed on the resistant edges of the lava-sheets. The cause of this is found in a moderate uplift of the whole country since it was reduced to a peneplain, introducing the second chapter in the history of its erosion. After this uplift a new cycle of erosive work was undertaken, and we now find ourselves at a moderate advance in this division of the valley's history. The softer beds have wasted away into lowlands, the harder ones still stand up as ridges. In the adjoining crystalline areas on the east and west, where most of the rocks are hard, the erosion of this cycle has made comparatively little progress; there the valleys are narrow and the interstream spaces are rolling uplands. In the Triassic belt, where most of the rocks are soft, the erosion of the same cycle has made much greater progress and reduced the area nearly to a second peneplain, except where the edges of the hard lava-sheets still hold up their crest lines to give some indication of the elevation that the whole surface once had. Here the valleys are broad and the interstream highlands are reduced to narrow ridges. This stage is indicated for our ten-mile-square area in Fig. 12, produced by removing from the previous form of the model certain little slips by which

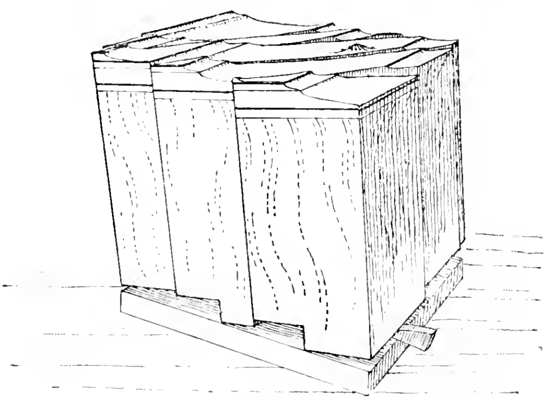


FIG. 12.

it is transformed from a peneplain to a broken country. It is practically in this stage that the region now stands. It has suffered certain slight changes by glaciation, and by small variations of level; but its main features are explained in accordance with the scheme thus presented; and from this general sketch we may return to the more especial consideration of the lost volcanoes.

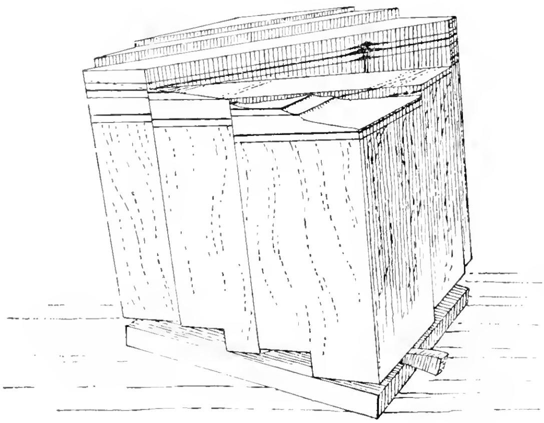


Fig. 13.

Fig. 13 presents a partial dissection of the tilted and faulted mass, in order to show the relation of the peneplain, produced at the end of the first cycle of erosion, to the volcanoes from which the lavas were poured out. The near corner block is stripped down to the present stage of topographic form; the second represents the peneplain stage; the other three retain their constructional form. It is here made apparent that by reason of the tilting, the volcanic cones were raised above the old base-level of erosion, and were hence doomed to destruction in the process of base-leveling. The further edges of their flows remain; the stump of the long chimney up through which their lavas rose to the surface is still discoverable, but the cones, where the chimney rose to the surface and gave forth the flows, are lost. Fig. 11, which represents the completed peneplain, has no trace of them, although the edges of the flows and the stump of the chimney can be identified. Fig. 12, illustrating the present form of the surface in a general way, shows no volcanoes, but it shows the edges of the flows and the stump of the chimney better than before, because they, being hard rocks, have held up their edges, while the surrounding weaker sandstones and shales have wasted away. Thus the Blue Hills have been developed: not by lifting up their heavy summits above the surrounding surface, but by holding hard to the form that they had at the end of the previous cycle, while the surrounding rocks have lost it. Denudation has not yet progressed deep enough to reveal the connection that very likely exists between the chimney and the lower intrusive sheet; this is still buried. Fig. 14 tells the same sequence of events, but in very diagrammatic style.

The wooden working model from which several of these fig-

ures are taken is a very wooden affair; it is rigid and straight-lined, instead of varying in irregular curves after a natural fashion; yet it may serve to present concrete illustrations of the successive stages through which the Meriden district has passed; and when thus viewed, the interest of the place grows wonder-

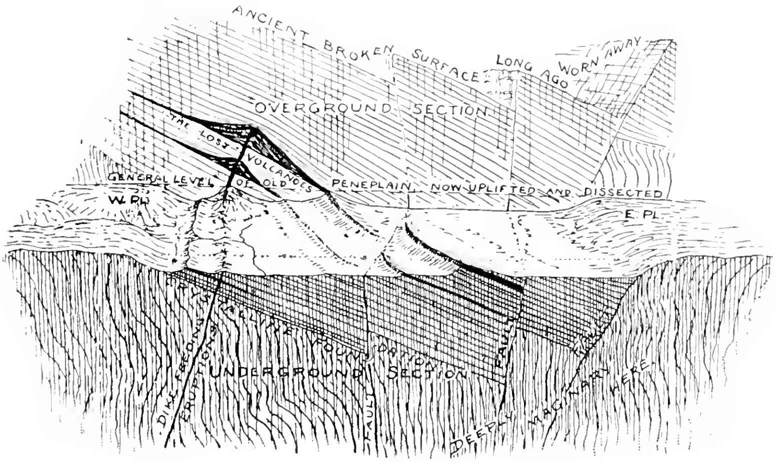


Fig. 14.—Diagrammatic View of a Faulted Monocline, between crystalline plateaus on east (E. Pl.) and west (W. Pl.), to illustrate the general structure of the Connecticut Triassic belt. Relative breadth much reduced. The supposed underground structure is shown in a vertical section in the foreground, and the inferred overground structure (now lost by erosion) in a vertical section in the background. A strip of actual surface lies between the two sections. The even peneplain, to which the whole mass was first reduced, is shown by dotted lines at the level of the eastern (E. Pl.) and western (W. Pl.) crystalline plateaus.

fully. Its scenery is not grand or magnificent; many other regions exceed it in height of mountains or depth of valleys; but it has a fine story to tell about its lost volcanoes, and it tells the story with great distinctness and emphasis when the listener passes by.

Important literary discoveries have attended the labors of Egyptologists during the present year. In January was announced the recovery of nearly a complete copy of the lost work of Aristotle on the Constitution of Athens—a document which throws new light on important events in Grecian history from the time of Solon down to the age of Pericles. The examination of the papyrus leaves of which certain coffins found at Tel Gurot, in the Fayoum, were made, has resulted in the recovery of several fragments of ancient literature of greater or less value; the most notable of which are a large part of a lost play, Antiope, of Euripides, and of parts of the Phædo of Plato, of a copy nearly contemporaneous with the authors, and furnishing a purer text than those from which the modern editions of this work are derived. Much was expected from the papyri found with the one hundred and sixty-three priestly mummies which were discovered last spring at Deir-el-Bahari, near Thebes; but, so far as they have been examined, they have afforded nothing more valuable than funereal texts.

THE TRAINING OF DOGS.*

By WESLEY MILLS, M. D.

AN analysis of our own psychic life, complex as much of it is, compared with that of the dog, shows that a great part of our mental processes are not concerned with abstractions and generalizations of a very high order, but with actual concrete perceptions and conceptions; that we think in pictures rather than words; that our thoughts are the result of past associations; that the machinery of the mind or brain is so connected that when one part is moved, so to speak, a whole series of connections are established. Hence the psychic life of every creature must be related essentially to its past experiences.

If this be true—and it can not be doubted—we think, then, the puppy's intelligence, like our own, begins to develop, and continues to do so exactly in relation to its environment. We can make that environment pretty much what we will; and with the dog, his master from the first, and always, is the principal factor.

Two extreme views have for a long period been entertained in regard to the training of the dog; the one that he is a wild, wayward creature to be "broken," the other that he needs no special correction if properly taught from the first. Neither is quite correct.

A puppy full of life tends to do exactly as his impulses move him, till the highest motive power, a desire to please his master, is substituted. It follows that a puppy can not be too soon led to understand that he has a master—kind, honest, intelligent, and firm. He must be consistent with his puppy. All caprice is fatal; it utterly confuses and demoralizes the dog.

Remembering that principle we laid down long ago, that the dog is very like ourselves, we can indicate a few principles for training that we think will meet the test of experience. The puppy at one period is like a young infant, later like a two-year-old child, and at the best most dogs never get beyond the intelligence of a young child in most respects, though in some qualities the wisest man is far behind the dog.

For practical purposes the puppy may be treated as an infant, but as a rapidly developing one. He gets his information through his senses, and his training must be related to this, and to the fact that he is a creature with strong impulses but little self-control.

It is a well-established law of the nervous system that what has happened once is likely to occur again under the same circum-

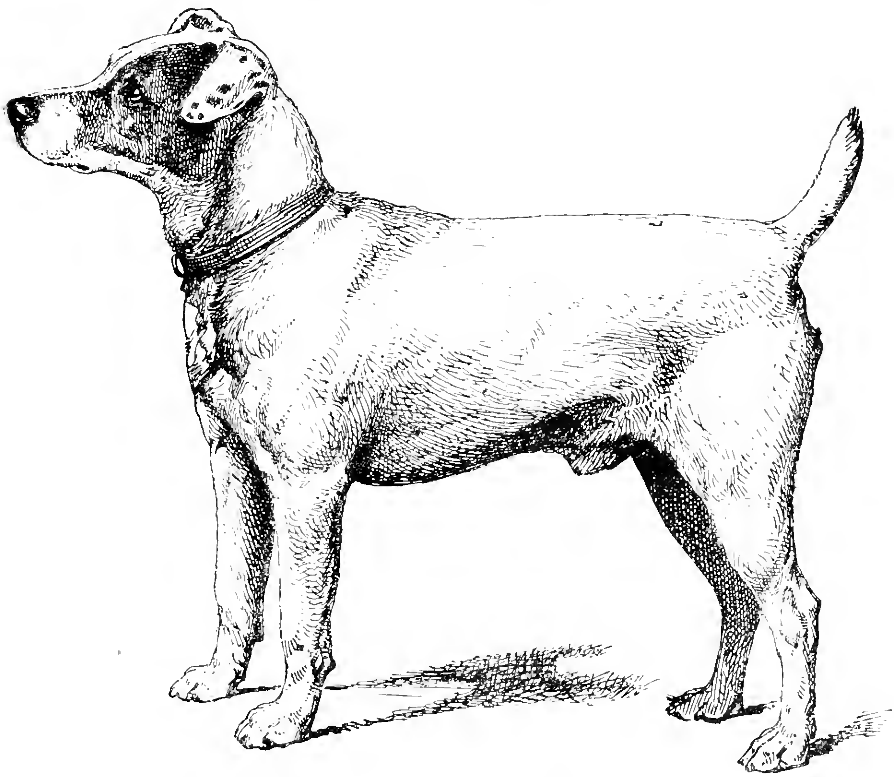
* From advance sheets of the author's book, The Dog in Health and Disease, in preparation by D. Appleton & Co.

stances; hence in the training of puppies first experiences are of much importance, and all the arrangements of the kennel, and in fact the whole environment, should be shaped in relation to this principle.

The puppy should not be allowed to get into habits which will later need correction. Let him from the first be encouraged in cleanliness, self-respect, love of esteem, respect for the rights of other puppies, his fellows, etc.

Very early begin to instill into him lessons of restraint, but only for the briefest periods, for the creature is as yet weak in brain and will power, though strong in instincts and impulses.

The master or trainer must not be associated in his mind with

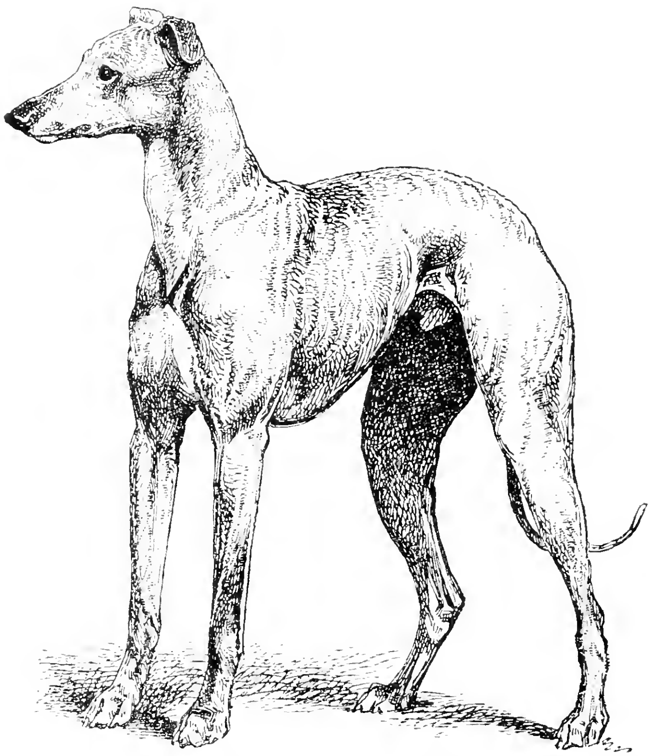


The Smooth-coated Fox-Terrier Champion The Belgravian.

unpleasantness, but with the reverse. Do not, therefore, punish him, but let him learn almost unconsciously that certain actions and certain pleasures are connected.

He should soon learn his name, should always come when called, but not be summoned too often, especially if playing. It is well to carry a bit of biscuit, cheese, etc., to reward him for coming at first. Later a pat of approbation will suffice.

The trainer should never undertake what he is not reasonably sure of accomplishing; and the first aim should always be to secure the dog's attention and interest, and to make the accomplishment pleasant. But he must know what is wanted, and if he can not comprehend this, the lesson is unsuitable at this period. He must, however, obey if he understands; gentle compulsion,



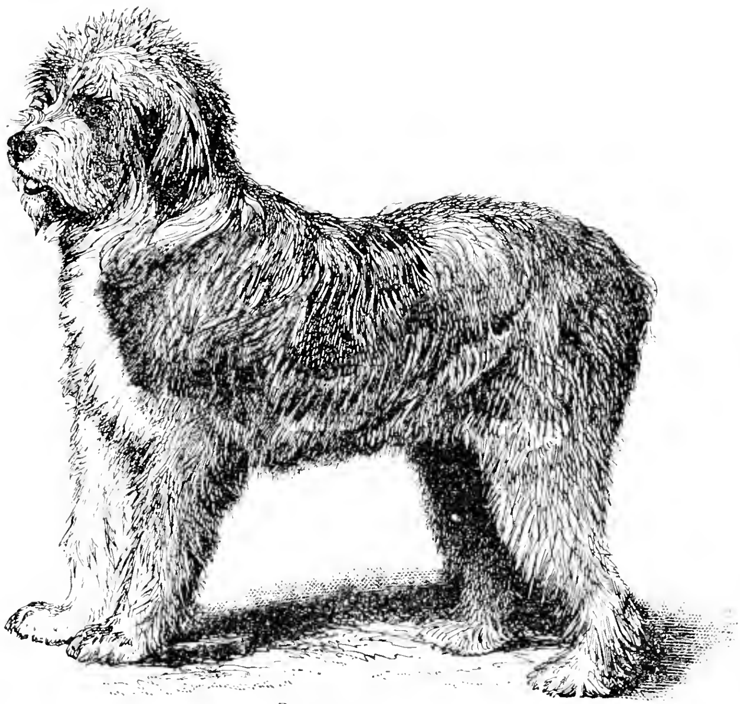
THE GREYHOUND FULLERTON. Thrice winner of the Waterloo cup, the most valuable of all coursing prizes.

when once the purpose is understood, may be exercised—e. g., if he will not come when he is called, he must not be whipped, as that will make the whole set of associations unpleasant, but he must be gently dragged by the back of the neck or bodily carried to where the trainer stood when the command was given; he must then be very gently reprimanded, then forgiven and made to feel that he is forgiven, and the lesson repeated, always rewarding obedience in some way.

Obedience to what is right pleasant, disobedience unpleasant, is the rule for us all, dogs and men. On these principles yard and house training is simple with well-bred dogs. They mean to please if they can. Make obedience and right-doing understood,

possible, and pleasant, and it will be preferred, especially if the wrong-doing is followed by the reverse experiences.

Dogs are not filthy in their habits, but some people who keep them are, and others do not understand what is required to enable a dog to follow his instincts of cleanliness. Where a dog has once been to respond to Nature's call, he tends to visit again, and this is a guide to enable us to avail of natural instinct to enable us to maintain cleanly surroundings. The same general principles apply when dogs are taken afield to be worked on some sort of game. At first the puppy may run toward almost every form of life he sees. This is natural, and he would not be worth his keeping if he did not show some such tendency to investigate the world about him.

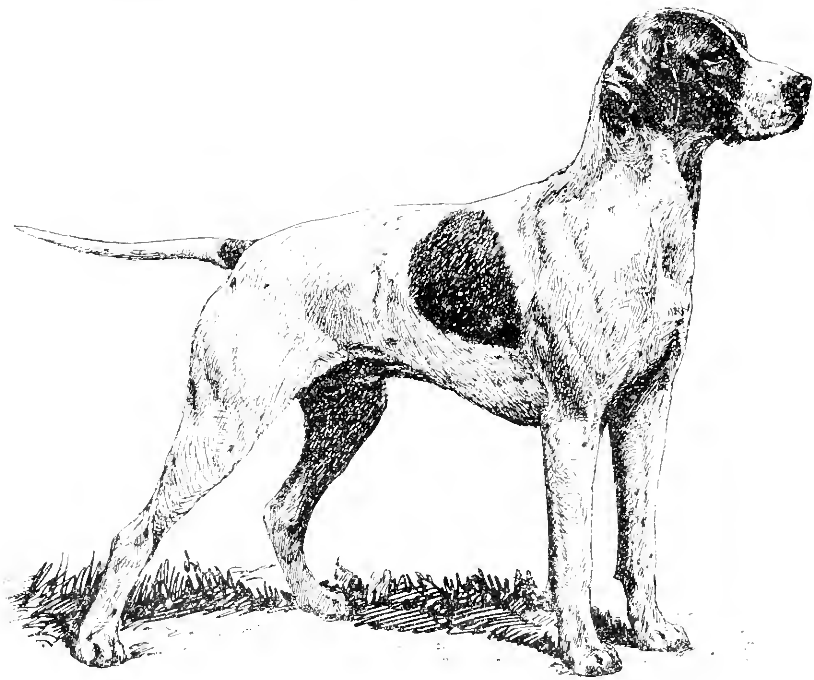


Bob-tail Sheep Dog.

But he must be restrained gradually. He must associate certain acts with the approval and others with the disapproval of him he respects, loves, and wishes greatly to please if he only knows how.

But such is the strength of the impulses of some puppies—now, we will suppose, six or eight months old—that they find it very difficult to restrain themselves. In such case we must lessen the stimulus or source of excitement rather than resort at once to the application of the principle of making the act unpleasant, as the use of a spiked collar or check-line.

These may later be useful in a modified form, but not at first; indeed, such methods are mostly quite unnecessary if a proper course be pursued. To illustrate: Suppose that a brace of setter puppies eight months old be taken to some wood where there is but little game. If they tend to run wild without any reference to the whereabouts of the trainer, and disregard his calls or his whistle, it surely would not be wise to whip those puppies soundly at once, attach a spiked collar or a check-line. To do so would probably confuse them, humiliate them, and retard their development in every way. Now, if the trainer secrete himself for a little while, these puppies will probably get frightened a little, feeling that they are lost, and will after this be more cautious how widely they range. When they do come in they may be scolded, but not whipped at this stage.



THE POINTER CHAMPION BRACKET.

It should be pointed out that all dogs should be taught to come in to whistle and to "down charge," or to drop at some word of command or at the upraising of the hand. This applies to all breeds, though more especially to dogs used in shooting. A dog in the field should also be guided by the motions of his trainer's hand. In learning this, the voice, the whistle, and often a long cord will be useful.

But the author wishes to avoid giving the impression that

there is only one way of accomplishing these things, as many previous writers seem to have thought, with the result that many who have attempted to follow these rigid rules have disgusted themselves and spoiled their dogs.

It is to be remembered that all lessons require frequent repetition. "Little and often" applies to training as a cardinal principle.

THE BLOODHOUND CHAMPION CROMWELL.

No one should undertake the training of a dog to work on game who is not possessed of patience and good temper. Lacking these, the puppy is apt to cause the trainer great worry and to get little good from him, if he be not actually spoiled. It is, in fact, better to go afield expecting that the puppy will do nothing as desired at first; then one is prepared for the worst, and may soon lay his plans to accomplish what he aims at, which must always be done in relation both to the dog and the circumstances.

But with dogs example is strong for good or evil. A steady, old trained dog is invaluable, while a disobedient, headstrong one will most assuredly ruin the puppy. But it is clearly foolish to expect a puppy under a certain age to work on game with an older dog—indeed, to work on game at all—though ranging, obeying the whistle, dropping, etc., should all be taught be-

fore the puppy is introduced to game. He must learn restraint and obedience, though it must be confessed that a day's work on actual game often quite transforms some puppies. But, as a rule, ten or twelve months will be quite soon enough to introduce a puppy to actual work.

Retrieving may be taught at home, using a soft ball of yarn, etc.; and if the puppy tends to bite on this, a few wires may be pushed through it. He must always at first be rewarded, when he brings the ball when thrown, with a little meat, cheese, etc. The words "fetch," "seek," etc., may be employed. Soon he will

The Irish Water-Spaniel Champion Shaun.

understand, and seek when no ball is thrown. To get him to "seek dead," some article may be hidden, and at first some meat, etc., must be employed, and the dog assisted to find it. Later a real bird may be used, or a wing. The same word of command should always be used. If the puppy will not bring the article—will not retrieve—take him to the spot and place it in his mouth.

holding it there and obliging him to carry it and finally deliver it to his trainer; reward him, and then try him again.

Some dogs take to retrieving naturally, requiring no training, while it is almost impossible to get others, often of high intelligence, to learn this at all.

Most puppies need a good deal of attention before they are perfectly steady on point, and to wing and shot, as their natural tendency is to secure the game when they have found it. How best to overcome this it is not always easy to decide. The dog must be encouraged to remain steady while his trainer moves up. Often the assistance of a second person to flush the bird will be

THE ROUGH-COATED ST. BERNARD CHAMPION SIR BEDIVERE.

useful, while the dog is approached and encouraged but not allowed to rush on. In this case a check-cord may be useful—to be employed as little as possible. The example of a reliable old dog is invaluable. Some form of check that will make the dog defeat or punish himself is preferable to direct administration of punishment by the trainer.

Gun-shyness is but an exaggerated form of fear of unusual noises, and must be treated accordingly. Let the dog be gradu-

ally introduced to louder and louder noises, never being allowed to escape, but being made to see that no harm is meant him or can happen to him. As to whether it is worth while to attempt to cure the worst cases will depend much on other circumstances, as the dog's breeding, general intelligence, nose, etc. It may or may not be inherited.

The author, in conversation with a very successful trainer of horses, once asked: "Can you teach any horse these things?" "I can do so, but it would not in many cases be worth while," was the reply. The same may be said of dogs: some of them are not adapted for certain kinds of work, and acquirements by nature to a sufficient degree, to make it worth while to persevere in teaching them; just as certain boys would never become expert enough at certain vocations to warrant their pursuit. But before abandoning a well-bred dog that seems to possess courage, "go," and fair general intelligence, it might be well to get the advice of some second person of much experience. Many dogs, unpromising at first, have become a great success afterward. The ability to read dogs very thoroughly is given to but a few men, and these, provided they have patience, good temper, and perseverance, must of course make the best trainers.

Though we have spoken chiefly of the training of hunting dogs, it is simply because that is usually more elaborate. All training is based essentially on the same principles, for the mind of the trainer and that of the dog are relative constants, while the circumstances are the variables.

In every instance the dog, from the earliest period, must know the trainer as his master, as one who knows his own mind and always is to be obeyed. But, in order to insure this, the principles we have already endeavored to enforce must be faithfully and intelligently applied; and it is very important, we repeat, that nothing be undertaken that can not be performed, and every advance in instruction approached by slight gradation and frequent repetition. All sound training must constantly keep in mind the individuality of the animal. The assumption that all dogs can be treated just alike is as erroneous as that all stomachs may have the same diet.

A dog kept constantly in a kennel can never attain his highest psychical development; and it is the author's experience that it does every dog good to bring him into the house occasionally for short periods and allow him to mingle with the family. It raises the animal in his own estimation, and attaches him to his master, for whom he will have increased respect.

SILK DRESSES AND EIGHT HOURS' WORK.

By J. B. MANN.

THE remark occurs in a recent editorial article in a prominent religious newspaper commending the eight-hour movement that if all the women who want silk dresses could have work, all the silk factories in the country could be set in motion and would furnish employment to the many thousands of people then idle; or words of that import. The proposition at first sight seems philosophical, but is it not reasoning in a circle? Having work, people will buy silks. If they buy silks, the factories will run. If the factories run, the people will have work. The old lady said: "This snow will never melt until the weather is warmer, and the weather can never be warmer until the snow has melted." Making the statement does not solve the problem.

When we look at the matter with care we find, sorrowfully, that the women who have no silks are the very ones who do the hardest work; and hence, as they are working clear up to the limit of human endurance to get bread, they have no time left over to put into silk dresses. This fact upsets the theory. Horace Greeley had a theory that poverty in cities could be cured by getting the poor to go West and engage in farming; entirely overlooking the fact that the next sixpence the poor man could get, and the next, and so on, must go for bread, thus putting a trip to the West out of the question.

But the imagining of philosophers in regard to the remedies is of small account, because want of work is not in this country one of the leading causes of poverty, as every careful observer knows. There are at least a dozen things which are more potent causes of the evil, and too much work, by which constitutions are broken and health ruined, is one of them. Is the remedy, therefore, not to be found in the eight-hour movement? I answer, No. The eight-hour movement does not approach the root of the evil. It is assumed by the promoters of the movement that society has a given amount of wants which require a given amount of labor to supply, and hence it is inferred that if all the workers cut down their hours from twelve to eight, the men now out of employment will come up and do the work the others have relinquished. In that way it is claimed that there will be work for all. Another theory is that men will accomplish as much in the long run in eight hours as they now do in twelve. It is evident on the face of it that both theories are not true, because if as much should be done by the present workers after the change as before, no more would be left for the others to do than they have now. And in that case the present workers would come much nearer to ex-

hausting their strength and injuring their health for the same money only that they get now. They would be no richer, and would drive their muscles and frames at a wearing pace not consistent with the laws of health.

But neither theory is true. Instead of there being a given amount of wants, as alleged, wants are found to be largely the result of means.

If the community have little, they require little, but as they become wealthy they spread out in proportion. People can't hire labor if they are poor, and hence to make a demand for labor somebody must be rich enough to pay for it. This is perfectly plain. Nobody goes in search of a poor man for employment, only in the last resort. It follows that whatever tends to wealth-making tends to want-making, and to an increase in the demand for labor and the supply of employment. On the other hand, whatever tends to a diminution of wealth tends necessarily to a diminution of the means to pay for labor, and also to less disposition to hire others to do the work. I think that these positions can not be successfully combated, and if not, we have a criterion by which to determine in what direction to look for improvement in the condition of the laboring man. Surely we shall never find it in anything that tends to a diminution of resources.

What is stated above in relation to wants being increased in proportion to the increase of wealth does not hold good in some individual cases, but in general it does, and it holds good to that extent that the common people everywhere accept it as a basis of action without stopping to reason about it at all, it is so natural. It is the reason why people leave a country like Ireland and come here. They expect to find dollars so plenty that, according to the old story, they do not deem it worth the while to pick up the quarters they may see lying on the wharf where they land. The same thing takes the smart boys from the poor country districts and small villages to the large towns and cities. They feel that they must get to places where there is an abundance of money. They do not fail to note that a man who has ten thousand dollars will build a three thousand dollar house, while the man with thirty thousand will build a house costing twelve thousand probably, and that calls for four times the labor of the other. They must get where such men abound, and where there are hundred-thousand-dollar men and millionaires, men who will build palaces, railroads, great warehouses, and ships. Poverty-stricken places are given a wide berth by all sensible folk, and so universal is the practice that we are not left in doubt as to the meaning of it.

Now wealth is principally the product of labor. Some get it by their own labor, and some by the labor of others; but however got by the individual, it is the result of personal or machine ex-

ertion and force. This necessitates the rule, therefore: More labor, more wealth; less labor, less wealth. This rule no one can escape or ignore.

The question now comes up, whether working eight hours a day tends to more riches or more production than working twelve. That it does not, I have already stated is my belief, and the belief is founded upon a long experience as a mechanic, farm-laborer, employer, and observer. In twenty years of labor in a shop, I never saw the time when I could do twelve hours' work in eight hours, except possibly for a single day. I never saw the man that could do it, and I never heard of one that could do it.

I never met one that said he thought it could be done for any length of time. It is a well-established fact that most men that pretend to work well have a working gait of their own, and can not be hurried beyond that advantageously. If they are, they do poor work or break down. This is so obvious that any pretense that as much will be accomplished in the shorter hours in farming or physical labor of any kind borders on the ridiculous. So obvious is it, that the principal advocates of the eight-hour movement have ceased to put their case on this ground, and rely upon the other theory, that less work will be done, and consequently more work will be left to be given to the laborers seeking for something to do.

If this latter view be adopted, it follows that the eight-hour men are philanthropists, who have sacrificed, or propose to sacrifice, one third of their possible earnings for the good of their fellow-men who have no work. This is incredible. The laborers themselves do not act from any such principle. They are thinking all the time that, instead of making a sacrifice, they are getting more leisure and making more money. They think that, instead of the work they could do in the four hours they have abandoned being done by the poor fellows who need help, it is not done at all, and, not being done at all, wages have risen, and thus they can get twelve hours' pay for eight hours' work.

In other words, they propose to increase the wealth of the community by lessening the amount produced by the community, thinking that, with a smaller amount to be divided as wages by one third, they can get a bigger share. Not only do they suppose this impossible thing, but they claim it has already been accomplished, and they say the advance in wages during the last thirty years has been caused by the reduction of hours.

Assuming this to be true, it is perfectly legitimate to argue that a further reduction of hours will work in the same way, and they name eight as the next station on the scale, with an intimation that soon six will be the point, and later four. I believe that most concede that it is necessary to have some work done, not

perceiving the absurdity into which they fall by the concession. Logically, we say that if one can earn a dollar in one hour, he can earn the same the next hour, and the next, and so on to the limit of his endurance. But, if we begin at the other end of the line of argument, and say that one can do as much and get as much pay in ten hours as in twelve, and then say that he can get as much pay in eight as in twelve, and then again as much in six, there is no logical stop anywhere till the bottom is reached. The stubborn fact of time is kicked out of the back door. It is the same as saying that a man works six hours, earns three dollars, and then works six more at the same work for nothing; while the same persons who say it have to admit that, if the man worked six hours in one day and six hours the next day, he would get as much pay for the second six as for the first six. Time is too tough a customer to be disposed of in that manner, and we must deal with him as a fact that has come to stay.

I think the most stupid are now able to see that one's ability to provide for his wants depends primarily upon his labor, and that time is a principal element in the case. He must have it and he must use it, and his prosperity, other things being equal, will be much or little as time is wisely used or neglected. The law of prosperity has not been repealed by any of the edicts of the leagues and unions. Not a fact or principle has been abolished or suspended. An hour lost is the loss of the product of labor that might have been performed in that hour, and it falls on the man who owned the hour, and not on another man or set of men. He does not escape his loss by the absurd theory that he lost it after four o'clock of Monday, instead of before ten Tuesday morning. It is an absolute loss, whatever the day when it was made. If the man worked for himself, as the saying is, he would see it was a total loss and nothing else; but, working for another, he fancies the other man is the loser, or else, by some hocus-pocus, it is shifted upon society. If men worked by the piece they would see how it is. Let two men start together in life as shoemakers, with a view to do their best in getting on in the world, as Henry Wilson did sixty years ago. They are equal in skill and endurance, and can work twelve hours at a fair stroke without impairing health. Working by the piece, they find they can earn sixteen and two thirds cents per hour, or at the rate of two dollars a day. There is no difference between them in purpose, and only the small difference in the method of getting on, that James thinks he will sooner get in comfortable circumstances by working twelve hours a day, and John imagines that nine hours will answer the purpose just as well. At the end of the year of three hundred days they find that James has earned six hundred dollars, and John has earned but four hundred and fifty dollars.

They keep on at this rate ten years, and James has laid by two thousand dollars, and John nothing. Now, the two thousand of James earns ten dollars a month for him, and is better than a good apprentice, because he pays the fund no wages and it costs nothing for board. The reason why they are now so wide apart is that the extra hours of James have yielded fifteen hundred dollars principal in the ten years, and five hundred dollars in interest. John has nothing, because the expense of living of each and support of the families has amounted to four hundred and fifty dollars a year for each. In ten years more James will have interest-money sufficient to meet the family expense of four hundred and fifty dollars, and John will be with his nose still on the grindstone. A company of ten such men would lose in ten years twenty thousand dollars, and society would never make it up to them. Society would not pay for one hundred pairs of shoes when only seventy-five pairs were furnished, and the idea that it would is a delusion. Many workingmen have gained in the last half century, and the general condition has improved a great deal, but no part of the money gain has been due to less hours of labor. The people have grown rich during that time because they have availed themselves of the increased means of production which have been developed, and not because production has been lessened by the laborer refusing to work the former number of hours. Our riches are made up entirely of things produced, and when we say we are richer, we mean that we have more things which are the product of applied force. The increase of wealth, as was stated before, has increased the disposition to build more expensive houses and buy more elaborate furniture, and have an endless variety of things deemed needless a few years ago, causing a demand for labor and an increase of wages that in a measure counterbalances the loss of time. This is what has helped labor, and not the refusal to work more than ten hours. Had the other two hours a day been worked, the laborer would have been still richer by one sixth of the principal and all the interest on his extra earnings during the whole time that the ten-hour rule has prevailed. The workman, then, has simply exchanged the wealth he might have got in the extra two hours for leisure of two hours; a very proper thing to do if he can afford it, but he hasn't had the leisure and the money he might have earned in the lost time also.

The community is also the poorer to the same extent. It misses just the amount of wealth that the laborer has failed to produce in his idle hours. It finds on its hands a large body of men advanced in years who might now be comfortable, but are still struggling to meet the cost of increase in the style of living consequent on the increase of wealth, when they are more than one sixth short in possible resources.

The trouble with the eight-hour plan, however, is not here so much as in the fact that so many men who can not get a decent living on eight hours of labor are taught that they can earn as much in that time as in twelve hours, and are made to believe it, or else denounced as scabs and nobodies. If the laborer attempts to work more hours, he is called an enemy of workingmen, an enemy of progress, and so on, until he is forced to a life of partial idleness, while his children are suffering for comforts which his labor could furnish without injury to himself or to any mortal in the world. There are hosts of men somewhat deficient in skill who could partially make up in longer hours their lack of efficiency were they permitted to, but as they are not, they are forced to live on the verge of beggary all their days, and are taught to curse society for not giving them a better chance in the world. How many such there are in this country God only knows, but that they are numerous there can be no doubt. The evil is prodigious, and is not confined to this class entirely. Others are affected in an unfavorable way. The idea is encouraged that labor is an evil to be shunned like vice, and that there is a way to enjoy the fruits of labor without its exercise. The consequence of the prevalence of this idea is, that men are led to hope for the impossible, to trust in its coming, and to neglect the golden opportunities for making their way which lie directly before them. The man who thinks he is getting richer by three or four hours of idleness every day is not likely to set much value on time, and when he does not do that, he tends to unthriftiness, and in time will become a good deal of an idler if not a downright loafer. When the whole community becomes thus affected, the consequences will be serious. They are serious already.

That this is a remarkable age in which we live is the general belief, but of the things that go to make up this belief nothing is stranger than the fact that when all mankind were devoting their best thoughts to the discovery of ways to increase resources and add to the general and individual wealth of society, when schemes of all sorts were being devised to save time in transportation of goods and mails and persons, in planting corn and making hay, in pumping water and feeding cattle, in tanning leather and making whisky, in mounting flights of stairs and raising broods of chickens—the workingmen as a body should band together and contrive a scheme to compel all hands to throw away absolutely one fourth of their chances to earn and lay up money, and provide for that period sure to come to all who live out the allotted years of man, when leisure will be not merely a luxury but a necessity; yet this is exactly what they have done. They have in a considerable degree neutralized the gains to themselves to be derived from the use of machinery, and thus have allowed the machines

to stand on the pay-rolls for the one quarter of wages they might have earned themselves. It was formerly supposed a wise saying that "the hand of the diligent maketh rich," but the proverb has been strangely modified in these days.

We are now told that the proverb was only three quarters true, and instead we must say, the man who works all of working time makes his neighbors poor, and will spend his last days in the work-house of the parish or on the highway as a tramp. Time lost is money lost to the one to whom the time belonged, whether he be rich or poor. The rich can lose some without feeling it, but the poor, alas! have none to spare. When this truth is fully appreciated by the destitute, a long stride will have been made toward the extinction of poverty.

DUST.

By J. G. McPHERSON.

SOME of the most enchanting phenomena in nature are dependent for their very existence upon singularly unimportant things; and some phenomena that in one form or another daily attract our attention are produced by startlingly overlooked material. What is the agent that magically transforms the leaden heavens into the gorgeous afterglow of autumn, when the varied and evanescent colors chase each other in fantastic brilliancy? What is the source of the beautiful, brilliant, and varied coloring of the waters of the Mediterranean, or of the most extraordinary brilliant blue of the crystal waters of the tarns in the Cordilleras? What produces the awe-inspiring deep blue of the zenith in a clear summer evening, when the eye tries to reach the absolute? Whence come the gentle refreshing rain, the biting sleet, the stupefying fog, the chilling mist, the virgin snow, the glimmering haze, or the pelting hail? What raises water to the state of ebullition in the process of heat application for boiling? What is the source of much of the wound putrefaction, and the generation and spread of sickness and disease? What, in fact, is one of the most marvelous agents in producing beauty for the eye's gratification, refreshment to the arid soil, sickness and death to the frame of man and beast? That agent is *dust*.

And yet no significance is given to dust unless it appears in large and troublesome quantities. It requires the persistent annoyance of dust-clouds to excite any attention. Dust, however, demands to be noticed, even when not in that collected, irritating motion known in Scotland as *stour*. The dust-particles floating in the atmosphere or suspended in the water have a most impor-

tant influence upon the imagination, as well as upon the comfort of man. Though so small that a microscope magnifying 1,600 diameters is required to discern them, they at times sorely tax the patience of the tidy housekeeper and the skill of the anxious surgeon. An æsthetic eye is charmed with their gorgeous transformation effects; yet some are more real emissaries of evil than poet or painter ever conceived.

Until the famous discovery made by Mr. John Aitken, of Falkirk, a few years ago, no one could reasonably account for the existence of rain. It was said by physicists that cloud-particles were attracted by the law of gravitation under certain conditions of temperature and pressure. But this famous experimentalist and observer found out that without dust there could be no rain; there would be nothing but continuous dew. Our bodies and roads would be always wet. There would be no need for umbrellas, and the housekeeper's temper would be sorely tried with the dripping walls.

A very easy experiment will show that where there is no dust there can be no fog. If common air be driven through a filter of cotton-wool into an exhausted glass receiver, the vessel contains pure air without dust, the dust having been seized by the cotton-wool. If a vessel containing common air be placed beside it, the eye is unable to detect any difference in the contents of the vessels, so very fine and invisible is the dust. If both vessels be connected with a boiler by means of pipes, and steam be passed into both, the observer will be astonished at the contrast presented. In the vessel containing common air the steam will be seen, as soon as it enters, rising in a close white cloud; then a beautiful foggy mass will fill the vessel, so dense that it can not be seen through. On the other hand, in the vessel containing the filtered, dustless air, the steam is not seen at all; though the eye be strained, no particles of moisture are discernible; there is no cloudiness whatever. In the one case, where there was the ordinary air impregnated with invisible dust, fog at once appeared; whereas in the other case, the absence of the dust prevented the water-vapor from condensing into fog. Invisible dust, then, is required in the air for the production of fog, cloud, mist, snow, sleet, hail, haze, and rain, according to the temperature and pressure of the air.

The old theory of particles of water-vapor combining with each other to form a cloud-particle is now exploded. Dust is required as a free surface on which the vapor-particles will condense. The fine particles of dust in the air attract the vapor-particles and form fog-particles. When there is abundance of dust in the air and little water-vapor present, there is an over proportion of dust-particles; and the fog-particles are, in consequence,

closely packed, but light in form and small in size, taking the more flimsy appearance of fog. But if the dust-particles are fewer in proportion to the number of molecules of water-vapor, each particle soon gets weighted, becomes visible, and falls in mist or rain.

This can be shown by experiment. Let a jet of steam be passed into a glass receiver containing common air, and it will be soon filled with dense fog. Shut off the steam and allow the fog to settle. The air again becomes clear. Admit more steam, and the water-particles will seize hold of the dust-particles that previously escaped. Fog will be formed, but it will not be so dense. Again, shut off the steam, and allow the fog to settle and the air to clear. Then admit some steam, and very likely the condensed vapor will fall as rain. If the experiment be often enough repeated, rain instead of fog will be formed, because there are comparatively few solid particles on which the moisture can condense. When, then, dust is present in large quantities, the condensed vapor produces a fog; there are so many particles of dust to which the vapor can adhere that each can only get a very small share—so small, in fact, that the weight of the dust is scarcely affected by the addition of the vapor—and the fog formed remains for a time suspended in the air, too light to fall to the ground. But when the number of dust-particles is fewer, each particle can take hold of a greater space of the water-vapor, and mist particles or even rain-particles will be formed.

This principle that every fog-particle has embosomed in it an invisible dust-particle led Mr. Aitken to one of the most startling discoveries of our day—the enumeration of the dust-particles of the air. Thirty years ago M. Pasteur succeeded in counting the organic particles in the air; these are comparatively few, whereas the number of inorganic particles is legion. Dr. Koch, Dr. Percy Frankland, and others have devoted considerable attention to the enumeration of the micro-organisms in the air, and Mr. A. Wynter Blyth, the public analyst in London, has done good service in counting the micro-organisms in the different kinds of water in the vicinity. Marvelous as are the results, still the process was comparatively easy. By generating the colonies in a prepared gelatin, the number of microbes can be easily ascertained.

But to attempt to count the inorganic dust seemed almost equal in audacity to the scaling of the heavens. The numbering of the dust of the air, like the numbering of the hairs of the head, was considered as one of the prerogatives of the Deity. Yet Mr. Aitken has counted the "gay motes that people the sunbeams." Though he could not enlarge the particles by a nutritive process, as in the case of the organic particles, he has been able to enlarge them by transferring them into fog-particles, so as to

be within the possibility of accurate enumeration. His plan is to dilute a definite small quantity of common air with a fixed large quantity of filtered, dustless air, and allow the mixture to be supersaturated by water-vapor; the few particles of dust seize the moisture, become visible in drops, fall on a divided plate, and are there counted by means of a magnifying-glass.

The instrument employed by Mr. Aitken has taken various forms; in fact, he has so far improved it that it can be carried in the coat-pocket. But the original instrument, which we saw and used, is most easily described without the aid of diagrams. But, instead of his decimal system of measurements, we will use the ordinary system, that the dimensions may be more easily grasped by the general reader. Into a common glass flask of carafe-shape, and flat-bottomed, of thirty cubic inches capacity, are passed two small tubes, at the end of one of which is attached a square silver table, one inch long. A little water having been inserted, the flask is inverted, and the table is placed exactly one inch from the inverted bottom, so that the contents of the air above the table and below the bottom are one cubic inch. The observing table has been divided into a hundred equal squares, and is highly polished, with the burnishing all in one direction, so that during the observations it appears dark, when the fine mist-particles, falling on it, glisten opal-like with the reflected light, in order that they may be more easily counted. The tube to which the silver table is attached is connected with two stop-cocks, one of which can admit a small measured portion of the air to be examined. The other tube in the flask is connected with an exhausting syringe, of ten cubic inches capacity. Over the flask is placed a covering colored black in the inside. In the top of this cover is inserted a powerful magnifying-glass, through which the particles on the silver table can be easily seen and counted. A little to the side of this magnifier is an opening in the cover, through which light is concentrated on the silver table. This light, again, has had to pass through a spherical globe of water, in order to abstract the heat rays, which might vitiate the observations.

To perform the experiment, the air in the flask is exhausted by the syringe. The flask is then filled with pure filtered air. One tenth of a cubic inch of the air to be examined is then introduced into the flask, and mixed with the thirty cubic inches of dustless air. After one stroke of the syringe this mixed air is made to occupy an additional space of ten cubic inches; and this rarefying of the air so chills it that condensation of the water-vapor takes place on the dust-particles. The observer, looking through the magnifying-glass upon the silver table, sees the mist-particles fall like an opal shower on the table, and counts the number on a single square in two or three places, striking an

average in his mind. Suppose the average number upon one of these squares were five, then on the whole table there would be 500; and these 500 mist-particles contain the 500 dust-particles which floated invisibly in the cubic inch of mixed air above the table. But, as there are forty cubic inches of mixed air in the flask and syringe, the number of dust-particles in the whole is 40 times 500 = 20,000; that is, there are 20,000 dust-particles in the small quantity of common air (one tenth of a cubic inch) which was introduced for examination; in other words, a cubic inch of that air contains 200,000 dust-particles—nearly a quarter of a million.

By this process Mr. Aitken has been able to count 7,500,000 of dust-particles in one cubic inch of the ordinary air of Glasgow. We counted with him 4,000,000 in a cubic inch of the air outside of the Royal Society Rooms, Princes Street, Edinburgh. Inside the room, after the Fellows had met for two hours, on a winter evening—the fire and gas having been burning for a considerable time—we found 6,500,000 in a cubic inch of the air four feet from the floor; but near the ceiling no fewer than 57,500,000 were counted in the cubic inch. He counted in one cubic inch of air immediately above a Bunsen flame the fabulous number of 489,000,000 of dust-particles. The lowest number he ever counted was at Lucerne, in Switzerland: 3,500 in the cubic inch. On the summit of Ben Nevis the observer, using Mr. Aitken's apparatus, counted from 214,400 down to 840 in the cubic inch. But on the morning of the 21st of July last there was a most marvelous observation made. Though at the sea-level the wind was steady, and the thermometer did not vary, at the summit the wind suddenly veered round to the opposite direction of that below, blowing out of a cyclone, and the temperature rose ten degrees. In consequence the extraordinarily low mean of only thirty-four dust-particles to the cubic inch was observed.

We now come to the most pleasant of the investigations in connection with dust. The very brilliant sunsets which began in the autumn of 1883, and continued during successive seasons with gradually decreasing grandeur, have arrested the attention of the physicist as well as of the general observer. What is the cause of the brilliant coloring in these remarkable sunsets? What is the source of the immense wealth of the various shades of red which have been so universally admired? Gazing on a gorgeous sunset, the whole western heavens glowing with roseate hues, the observer sees the colors melting away before his eyes and becoming transformed into different hues. The clouds are of different sizes and of all shapes. Some float virgin-like in silver folds, others voyage in golden groups; some are embroidered with burning crimson, others are like "islands all lovely in an emerald sea." And when the flood of rosy light, as it deepens into bright crimson, brings

out into bold relief the circlet of flaming mountain peaks, it is like a gorgeous transformation scene. Stranger still, when the sun sinks below the horizon, and a dull ashen gray has possessed the western heavens, what occasions the hectic flush on the eastern horizon? Gradually the clouds are tinged with light red from the eastern horizon all over the zenith; whence comes the coloring?

It is a strange coincidence that these remarkably fine sunsets have been since the tremendous eruptions at Krakatoa, in the Straits of Sunda. Along with the lava eruption there was ejected an enormous quantity of fine dust. The decks of vessels, hundreds of miles away, were covered with it. Mr. Verbreek computed that no less than 70,000 cubic yards of dust actually fell round the volcano. This will give an idea of the enormous quantity of dust still floating in the atmosphere, and drifting all over the world. In the upper atmosphere, too, there must always be dust, for without the dust no clouds could be formed to shield us from the sun's scorching rays; and of cosmic dust there must be a considerable quantity in the air, produced by the waste from the millions of meteors that daily fall into it. Mr. Aitken has ably shown that the brilliancy and variety of the coloring are due to the suspended dust in the atmosphere.

Observers of the gorgeous sunsets and afterglows have been most particularly struck with the immense wealth of the various shades and tints of red. Now, if the glowing colors are due to the presence of dust in the air, there must be somewhere a display of the colors complementary to the reds, because the dust acts by a selective dispersion of the colors. The small dust-particles arrest the direct course of the rays of light and reflect them in all directions; but they principally reflect the rays of the violet end of the spectrum, while the red rays pass on almost unchecked. Overhead deep blue reigns in awe-inspiring glory. As the sun passes below the horizon, and the lower stratum of air, with its larger particles of dust which reflect light, ceases to be illuminated, the depth and fullness of the blue most intensely increase. This effect is produced by the very fine particles of dust in the sky overhead being unable to scatter any colors unless those of short wave-lengths at the violet end of the spectrum. Thus we see, above, blue in its intensity without any of the red colors. When, however, the observer brings his eyes down in any direction except the west, he will see the blue mellowing into blue-green, green, and then rose color. And some of the most beautiful and delicate rose tints are formed by the air cooling and depositing its moisture on the particles of dust, increasing the size of the particles till they are sufficiently large to stop and spread the red rays, when the sky glows with a strange aurora-like light.

The dust theory of the splendor of sunset coloring is strengthened by the often glorious afterglows. The fiercely brilliant streaks of red have disappeared; over the mountain ridge a flush of orange hovers, and softens the approaching blue. The western hills, that once stood out bronzed against the glare of light, are somber-hued. But suddenly, as by a fairy's wand, the roseate flush of beauty rises in the east, and stretches its beautiful tints all over the sky. As the sun sinks, but before it ceases to shine on our atmosphere, the temperature of the air begins to fall, and its cooling is accompanied by an increase in the size of the particles floating in it by the condensation of the water-vapor. The particles to the east lose the sun first, and are thus first cooled. Accordingly, the rays in that direction are best sifted by the larger water-clad particles of dust, and the roseate coloring is there more distinct than in the north and south. As the sun sinks further, the particles overhead become cooler, and attract the water-vapor; thus they increase in size, and thereby reflect the red rays. Here the red hues, at first visible in the east, slowly rise, pass overhead, and descend in the west to form the charming afterglow. Sometimes a flood of glory will roll once more along the summits of the hills, entrancing the attention of the artistic spectator.

All examinations of the volcanic dust lately collected from the atmosphere show that a great quantity of it is composed of small glassy crystals. An abundance of these would quite account for the peculiarity in the visibility of the first glow; and the evidence seems to indicate that the quantity of such crystals is sufficient to produce the result. When these are fully illuminated, they become in turn a source of illumination, and reflect their reddish light all around. In winter sunsets, the water-clad dust-particles become frozen, and the peculiarly brilliant crimson is seen, coloring the dead beech leaves and red sandstone houses, and making them appear to be painted with vermilion.

If, then, there were no fine dust-particles in the upper strata of the atmosphere, the sunset effect would be paler; if there were no large particles in the lower strata, the beautiful sunset effects would cease. In fact, if our atmosphere were perfectly void of dust-particles, the sun's light would simply pass through without being seen, and soon after the sun dipped below the horizon total darkness would ensue. The length of our twilight, therefore, depends on the amount of dust in one form or another in our atmosphere. Not only, then, would a dustless atmosphere have no clouds, but there would be no charming sunsets, and no thought-inspiring twilights.

There is a generally prevalent fallacy that the coloring at sunrise or sunset is much finer when seen from the summit of a

mountain than from a valley. To this matter Mr. Aitken has been giving some attention, and his observations point the very opposite way, corroborative of his dust-theory. From the summit of the Rigi Kulm in Switzerland he saw several sunsets, but was disappointed with the flatness and weakness of the coloring; whereas in the valley, on the same evenings, careful observers were enchanted with the gorgeous display. The lower dusty humid air was the chief source of the color in the sunset effects. His opinon is strengthened by the fact that when from the summit he saw large cumulous clouds, the near ones were always snowy white, while it was only the distant ones that were tarnished yellow, showing that the light came to these clouds unchanged, and it was only the air between the far-distant clouds and his eye that tarnished them yellow. On the mountain-top it required a great distance to give even a slight coloring. The larger and more numerous dust-particles in the air of the valley are, therefore, productive of more brilliant coloring in sunrise or sunset than the smaller and fewer particles on the mountain-top.

It is now admitted that the inherent hue of water is blueness. Even distilled water has been proved to be almost exactly of the same tint as a solution of Prussian blue. This is corroborated by the fact that the purer the water is in nature, the bluer is the hue. But though the selective absorption of the water determines its blueness, it is the dust-particles suspended in it which determine its brilliancy. If the water of the Mediterranean be taken from different places and examined by means of a concentrated beam of light, it is seen to hold in suspension millions of dust-particles of different kinds. To this fine dust it owes its beautiful, brilliant, and varied coloring. Where there are few particles there is little light reflected, and the color of the water is deep blue; but where there are many particles more light is reflected, and the color is chalky blue-green. Along its shores the Mediterranean washes the rocks and rubs off the minute solid particles, which make the water beautifully brilliant.

That this is the case can be illustrated. If a dark metal vessel be filled with a weak solution of Prussian blue, the water will appear quite dark and void of color. But if some fine white powder be thrown into the vessel, the water at once becomes of a brilliant blue color; if more powder be added, the brilliancy increases. This accounts for the changes of depth and brilliancy of color in the several shores of the Mediterranean. In Lake Como, where there is an entire absence of white dust-particles, the water is of a deep blue color, but void of brilliancy; but, where the lake enters the river Adda, the increase of the current rubs down fine reflecting particles from the rocks; in consequence, there the water is of a finer blue. When the dust-particles carried down

by the Rhône spread out into the center of the Lake of Geneva, the color assumes the deeper blue, rivaling in brilliancy any water in the world.

The phenomenon called a haze puzzled investigators until Mr. Aitken explained it on the principle of the condensing power of dust-particles Haze is only an arrested form of condensation of water-vapor. If one half of a dusty pane of glass be cleaned in cold weather, the clean part will remain undewed, while the dusty part is damp to the eye and greasy to the touch. Why is this ?

Fit up an open box with two pipes, one for taking in water and the other for taking away the overflow. Inside fix a thermometer. Cover the top edge of the box with India rubber, and fix down with spring catches (so as to make the box water-tight) a glass mirror, on which dust has been allowed to collect for some time. Clean the dust carefully off one half of the mirror, so that one half of the glass covering the box is clean and the other half dusty. Pour cold water through the pipe into the box, so as to lower the temperature of the mirror, and carefully observe when condensation begins on each of the halves, taking a note of the temperature. It will be found that the condensation of the water-vapor appears on the dust-particles before coming down to the natural dew-point temperature of the clean glass. The difference between the two temperatures indicates the temperature above the dew-point at which the dust condenses the water-vapor. Mr. Aitken found that the condensing power of the dust in the air of a smoking-room varied from 4° to 8° Fahr. above the dew-point, whenever that of the outer air varied from 3° to 5½°.

Moisture is, therefore, deposited on the dust-particles of the air which is not saturated, and condensation takes place while the air is comparatively dry, before the temperature is lowered to the dew-point. The clearest air, then, has some haze; and, as the humidity increases, the thickness of the air increases. In all haze the temperature is above the dew-point. And in all circumstances the haze can be accounted for by the condensing power of the dust-particles in the atmosphere at a higher temperature than that required for the formation of fogs, or mists, or rain.

But whence comes the dust ? Meteoric waste and volcanic *débris* have already been mentioned. On or near the sea the air is impregnated by the fine brine-dust lashed by the waves and broken upon the rocks and vessel-sides. But the most active of all substances as a fog-producer in towns is burned sulphur. No less than three hundred and fifty tons of the products of the combustion of sulphur from the coal are thrown into the atmosphere of London every winter day. But the powerful deodorizing and antiseptic properties of the sulphur assist in sanitation ; and it is better to bear the inconvenience of fogs than be subjected to the

evils of a pestilence. At the same time it should be known that smoke-particles can be deposited by the agency of electricity. If an electric discharge be passed through a jar containing smoke, the dust will be deposited so as to make the air clear. Lightning clears the air, restoring the devitalized oxygen and depositing the dust on the ground. Might it not, then, be possible for strong enough electrical discharges from several large voltaic batteries to attack the smoke in the air of large cities, and especially the fumes from chemical works, so as to bring down the dust in the form of rain instead of leaving it in the form of mystifying fog?

Organic germs also float in the air. Some are being vomited into the air from the pestilential hot-beds of the lowest slums. In a filthy town no less than thirty millions of bacteria in a year will be deposited by the rain upon every square yard of surface. A man breathes thirty-six germs every minute in a close town, and double that in a close bedroom. The wonder is how people escape sickness, though most of these germs are not deadly. In a healthy man, however, the warm lung surfaces repel the colder dust-particles of all kinds, and the moisture evaporating from the surface of the air-tubes helps the prevention of the dust clinging to the surface.

From this outline the reader will observe the increasing importance of careful attention to the influence of dust in the economy of nature. As a sickness-bearer and a death-bearer it must be attacked and rendered harmless; as a source of beauty unrivaled we must rejoice at its existence. The clouds that shelter us from the sun's scorching heat, the refreshing showers that clear the air and cheer the soil, the brilliancy of the deep-blue sea and lake, the charms of twilight, and above all the glory of the colors of sunrise and sunset, are all dependent upon the existence of millions of dust-particles which are within the power of man's enumeration. No more brilliant achievement has been made in the field of meteorology than during the past few years by the careful observation and inventive genius of Mr. Aitken in connection with the importance of dust in air and water.—*Longman's Magazine.*

It appears, from the complete edition of the works of Huygens, now in course of publication at The Hague, that as soon as he had succeeded in applying the pendulum to the regulating of clocks, claims were set up for priority in the invention. The best-founded claims were those of Galileo, which were championed by Prince Leopold de' Medici. According to the formal statement drawn up by Viviani, Galileo had conceived the idea, but failed to make the application of it. He had a pendulum connected with wheel-work, but omitted to provide any weights, springs, or other means of keeping the machinery in motion.

SKETCH OF DIMITRI IVANOVICH MENDELEEF.

THE discovery of the periodic law in the atomic weights of the elements has furnished chemists with a new standard of accuracy and a new guide in research. While it must be regarded as Mendeleef's most conspicuous scientific achievement, the Russian chemist is the author of many other labors of hardly less real importance.

Dimitri Ivanovich Mendeleef was born at Tobolsk, Siberia, February 7, 1834, the seventeenth and youngest child of Ivan Paulovich Mendeleef, director of the gymnasium there. Soon after his birth the father became blind and had to resign his position, leaving the care of the family upon the mother, a competent and energetic woman. She established and managed a glass-works, and brought up and educated her family upon its profits. Dimitri was sent to the gymnasium at Tobolsk, and, at sixteen years of age, to St. Petersburg, where he was to study chemistry in the university, under Zinin; but was transferred to the Pedagogical Institute in the same building with the university, where he entered the physico-mathematical department, or that of the natural sciences. He studied chemistry, physics, mathematics, botany, zoölogy, mineralogy, and astronomy, under teachers who were most of them also professors in the university. Having concluded his course here, he was appointed to the gymnasium at Simferopol, in the Crimea; then, during the Crimean War, to a gymnasium in Odessa; and in 1856 he became a *Privat Docent* in the University of St. Petersburg, where he had already received the degree of Master of Chemistry. In 1859, having obtained permission from the Government to travel, he became engaged at Heidelberg in the determination of the physical constants of chemical compounds. In 1863 he was made Professor of Chemistry at the Technological Institute of St. Petersburg, and in 1866 at the university, where he received the degree of Doctor of Chemistry.

Mendeleef had already, before his engagement as a *Privat Docent*, entered upon the career of research and publication in which he has so brilliantly distinguished himself. His first paper, on Isomorphism, was prepared while he was still in the Pedagogical Institute. He entered into the discussion of the relations between the specific gravities of substances and their molecular weights, and presented to the physico-mathematical faculty of the university a number of theses or problems relating to specific volumes; and as early as 1856 he accepted Gerhardt's mode of determining the chemical molecule. His researches on specific volumes were continued till 1870, and in them, according

to Prof. T. E. Thorpe, from whose memoir in Nature we derive most of the material of this sketch, he extends Kopp's generalizations, and traces the specific volumes of substances through various phases of chemical changes. In a paper on the thermal expansion of liquids above their boiling-points, he showed that the empirical expressions given by Kopp, Pierre, and others are equally applicable to much higher temperatures, and that the expansion-coefficient gradually increases with the diminution in molecular cohesion of the liquid, until, in the case of some liquids, it becomes even greater than that of the gas. In 1883 he contributed to the English Chemical Society a paper giving a simple general expression for the expansion of liquids under constant pressure between zero and their boiling-points—a formula analogous to that which expresses Gay-Lussac's law of the uniformity of expansion of gases; but which, like Gay-Lussac's law, however correct in theory, is subject to deviations in application. These deviations were shown to be related to the molecular weights of the gases.

Researches in thermal chemistry, made in 1882, showed him that the data obtained by Berthelot, Thomson, and others, regarding the "heats of formation" of hydrocarbons, stood in need of correction, because allowance had not been made for the physical changes involving absorption or evolution of heat which accompany the chemical changes considered; and he gave a table giving the heats of formation from marsh-gas, carbon monoxide, and carbon dioxide, of a series of hydrocarbons, for chemical reactions that actually occurred, while the reactions given by Berthelot and others were not realized in practice.

In the investigation of solutions, Mendeleef propounded in 1884 the law that in solutions of salts the densities increase with the molecular weights; but if we take, instead of the molecular weights, the weights of their equivalents or those of the equivalents of metals, the regularity of increase disappears; and, though his research was not yet finished, he submitted an equation as preliminary to ulterior results promising to give a more general formula. The results of the determination of the specific gravity of aqueous solutions of alcohol were applied, according to Prof. Thorpe's memoir, toward the elucidation of a theory of solution in which Dalton's doctrine of the atomic constitution of matter could be reconciled with modern views concerning dissociation and the dynamical equilibrium of molecules. "According to Mendeleef, solutions are to be regarded as strictly definite atomic chemical combinations at temperatures higher than their dissociation temperature; and, just as definite chemical substances may be either formed or decomposed at temperatures which are higher than those at which dissociation commences, so we may have the same phenomenon in solutions; at ordinary temperatures they

can be either formed or decomposed. In addition, the equilibrium between the quantity of the definite compound and of its products of dissociation is defined by the laws of chemical equilibrium, which require a relation between equal volumes and their dependence on the mass of the active component parts."

In 1881 Mendeleef turned his attention to experiments on the elasticity of the gases, which he continued with the aid of several of his pupils. They led to many interesting results, among which was one showing that the deviations from Marriotte's law were in opposite directions at pressures above and below that of the atmosphere; indicating that air, for instance, as well as carbonic acid and sulphurous acid gases, experience a change of compressibility at certain pressures.

The results of these experiments were used in studies of the physical nature of the rarefied air of the upper atmosphere and the application of aëronautics, and he attempted to organize meteorological observations in the upper atmosphere by means of balloons.

The principles on which Mendeleef based the periodic law were first explained in a paper read before the Russian Chemical Society in 1869. As repeated by the author in his Faraday lecture to the English Chemical Society, they declare that the elements, if arranged according to their atomic weights, exhibit a periodicity of properties; that elements which are similar in chemical properties have atomic weights that are nearly of the same value or which increase regularly; that the arrangement of the elements or groups of elements in the order of their atomic weights corresponds to their so-called valencies, and, to some extent, to their distinctive chemical properties; that the elements which are the most widely diffused have small atomic weights; that the magnitude of the atomic weight determines the character of the element, just as the magnitude of the molecule determines the character of a compound body; that the discovery of many yet unknown elements may be expected; that the calculation of the atomic weight of an element may sometimes be amended by a knowledge of those of its contiguous elements; and that certain characteristic properties of elements can be foretold from their atomic weights. The theory was founded upon experiment, and assumed the adoption of the definite numerical values of the atomic weights, and the recognition that the relations between the atomic weights of analogous elements were governed by some general law, with a more accurate knowledge of the relations and analogies of the rarer elements as necessary for the completing and proving of it. In accordance with the theory as thus developed, a table was composed by Mendeleef and Victor Meyer, including nearly but not quite all of the elements

—for there were a few of which not enough was yet accurately known to determine their subjection to the rule—arranged in the order of their atomic weights and in groups or periods showing their relations and analogies. These periods might be said to be self-constituted; for, without departing from the orderly arrangement which Mendeleef had declared to exist, they so fell in line as to exhibit the very likenesses and differences which he had insisted upon as a part of his theory. Arranging them in parallel columns, it appeared that the several members of each period were substances that showed no similarity or community of chemical properties with one another; but that the members of the different periods showed an unmistakable parallelism with the corresponding members of the previous period. The columns also exhibited a regular gradation of electro-chemical properties, the most electro-positive elements occupying the places at their heads, and the extreme electro-negative elements the bottom places. The results of later discoveries and more accurate determinations have all been to confirm the correctness of the tabulation and the periodic theory. Thus scandium, gallium, and germanium, when discovered and examined, were found to fit into vacant places in the table, and to possess the atomic weights and the properties which the authors had predicted should belong to the elements falling in those places; and Mendeleef was able to say, in his Faraday lecture, delivered twenty years after the first suggestion of his theory, "When, in 1871, I described to the Russian Chemical Society the properties, clearly defined by the periodic law, which such elements ought to possess, I never hoped to live to mention their discovery to the Chemical Society of Great Britain as a confirmation of the exactitude and the generality of the periodic law." Up to the time of the formulation of this law, Prof. Thorpe says in his article: "The determination of the atomic value or valency of an element was a purely empirical matter, with no apparent necessary relation to the atomic value of other elements. But to-day this value is as much a matter of *a priori* knowledge as is the very existence of the element or any one of its properties. Striking examples of the aid which the law affords in determining the substituting value of an element are presented in the cases of indium, cerium, yttrium, beryllium, scandium, and thorium. In certain of these cases, the particular value demanded by the law, and the change in representation of the molecular composition of the compounds of these elements, have been confirmed by all those experimental criteria on which chemists are accustomed to depend. . . . The law has, moreover, enabled many of the physical properties of the elements to be referred to the principle of periodicity. At the Moscow Congress of Russian Physicists, in Au-

gust, 1879, Mendeleef pointed out the relations which existed between the density and the atomic weights of the elements; these were subsequently more fully examined by Lothar Meyer, and are embodied in the well-known curve in his Modern Theories of Chemistry. Similar relations have been observed in certain other properties, such as ductility, fusibility, hardness, volatility, crystalline form, and thermal expansion; in the refraction equivalents of the elements, and in their conductivities for heat and electricity; in their magnetic properties and electro-chemical behavior; in the heats of formation of their haloid compounds; and even in such properties as their elasticity, breaking stress, etc." While one may be readily inclined and many have been led to look for a connection between the periodic law and theories of the unitary origin of matter, Mendeleef has not allowed his studies in the subject to be embarrassed by any such prepossession. He said in his Faraday lecture: "The periodic law, based as it is on the solid and wholesome ground of experimental research, has been evolved independently of any conception as to the nature of the elements; it does not in the least originate in the idea of a unique matter; and it has no historical connection with that relic of the torments of classical thought, and therefore it affords no more indication of the unity of matter, or of the compound nature of the elements, than do the laws of Avogadro or Gerhardt, or the law of specific heats, or even the conclusions of spectrum analysis." The periodic law is developed in the author's Principles of Chemistry, which was first published in 1869, and appeared in a fourth edition, after a thorough revision, with many important additions and modifications, in 1882.

In a lecture before the Royal Institution in 1889, Mendeleef sought to apply a broader generalization and to discover a harmonious law regulating both chemical and astronomical phenomena. The immediate object of the lecture was to show that, starting from Newton's third law of motion, it is possible to preserve to chemistry all the advantages arising from structural teaching, without being obliged to build up molecules in solid and motionless figures, or to attempt to ascribe to atoms definite limited valencies, directions of cohesion, or affinities. He supposed that harmonious order reigns in the invisible and apparently chaotic motions of the universe, reaching from the stars to the minutest atoms, which is commonly mistaken for complete rest, but which is really a consequence of the conservation of dynamic equilibrium that was discovered by Newton, and has been traced by his successors as relative immobility in the midst of universal and active movement. The unseen world of chemical changes was regarded as analogous to the invisible world of the heavenly bodies, "since

our atoms form distinct portions of an invisible world, as planets, satellites, and comets form distinct portions of the astronomer's universe; our atoms may therefore be compared to the solar system, or to the systems of double or single stars. . . . Now that the indestructibility of the elements has been acknowledged, chemical changes can not be otherwise explained than as changes of motion, and the production by chemical reactions of galvanic currents, of light, of heat, or of steam-power, demonstrate visibly that the processes of chemical reaction are inevitably connected with enormous though unseen displacements, originating in the movements of atoms in molecules."

When, in 1880, the St. Petersburg Academy of Sciences refused, in the face of strongly signed recommendations, to elect Mendeleef a member in its Chemical Section, other scientific societies hastened to express their appreciation of him by making him an honorary member. Among these were the University of Moscow; the Russian Chemical and Physical Society, which presented him an address where it spoke of him as "a chemist who has no equal among Russian chemists"; the University of Kiev, the Society of Hygiene, etc. From England he received the Davy medal of the Royal Society in 1882, and the Faraday medal of the Chemical Society in 1889.

Prof. Mendeleef is the author of a treatise on Organic Chemistry which was a standard work in its time, and which, according to Prof. Thorpe, exercised a great influence in spreading abroad the conceptions which are associated with the development of modern chemistry. In 1863 he published a cyclopædia of chemical technology—the first really important work of the kind produced in Russia. He has frequently been commissioned to report on the progress of chemical industry as illustrated at the various international exhibitions. His investigations and reports on petroleum have been an important factor in the developing of the trade at Baku, and in removing the monopoly which formerly dominated the market there.

We quote again, in concluding, from Prof. Thorpe: "No man in Russia," he says, "has exercised a greater or more lasting influence on the development of physical science than Mendeleef. His mode of work and of thought is so absolutely his own, the manner of his teaching and lecturing is so entirely original, and the success of the great generalization with which his name and fame are bound up is so strikingly complete, that to the outer world of Europe and America he has become to Russia what Berzelius was to Sweden, or Liebig to Germany, or Dumas to France."

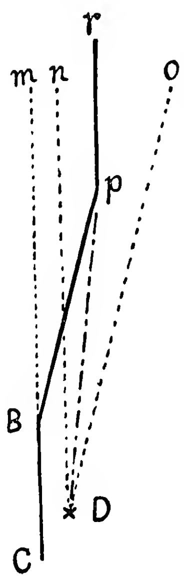
CORRESPONDENCE.

RIGHTING THE BICYCLE.

Editor Popular Science Monthly:

SIR: The article What keeps the Bicycler Upright? in the Monthly for last April was a very interesting one, especially to wheelmen, but I think it needs a little supplementary statement to make it complete. Mr. Charles B. Warring, the author, states that the rider's lost equilibrium is restored by bringing his point of support under him, and gives the impression that this point can be moved square to the right or left, like the foot of Mr. Warring's A-frame, saying nothing about the forward movement of the wheel. While agreeing with the main part of this statement, I think the righting of a bicycle can be more clearly and accurately explained as follows:

It is one of the elementary laws of physics that the center of gravity of a body must be over some point in its base in order that the body may stand without outside support. Now, the base on which a bicycle rests is only a line about half an inch wide, which joins the point B, in my figure, where the front wheel rests on the ground, with the point C, where the rear wheel rests. (I adopt Mr. Warring's lettering.) So long as a vertical line dropped from the center of gravity of the machine falls on some point of the line B C, the bicycle is in stable equilibrium; but, when it falls outside this narrow base, as at the point D, the equilibrium becomes unstable. In order to keep the machine and rider from coming to the ground, D must be brought upon B C; or, what is equivalent, B C must be brought under D. The latter is what is actually done. As the rider can not slide his machine sideways over the ground, he steers it obliquely toward the side on which he tends to fall. Thus, if the bicycle were running in the direction *C m*, he turns it toward the right so as to go in the direction *B p*. The center of gravity of the machine and its rider, which had been moving parallel to the course of the machine, is now acted on by two forces: (1) its acquired momentum, which tends to carry it on in the direction *D n*, and (2) the force constantly being received from the moving bicycle, which tends to carry it along the line *D o*, parallel to the new course of the machine. The result is, that it takes an intermediate direction, *D p*, in accordance with the law of the composition of forces. Thus, by being made to follow converging lines, D and B C are brought together at the point *p*. As quick as this is accomplished the bicycle must be turned again parallel to its original direction, or D will pass over to the left of B C and make the machine tilt toward that side. Hence, it is seen that righting a falling bicycle in motion involves two movements: first, a turn of the machine toward the side on which it tends to fall, then a return to its original course. Gravity was not mentioned among the forces considered above, but its action does not vitiate my explanation. I will add that I ride a bicycle myself, and so am acquainted with this matter on the practical as well as on the theoretical side. Very truly yours,



FREDERIK A. FERNALD,
L. A. W., 12,996, N. Y. Division.

[Substantially the same explanation as that given above has also been received from Mr. Thomas Cary Welch, of Buffalo, N. Y.—EDITOR.]

THE KELLEY'S ISLAND GROOVE.

Editor Popular Science Monthly:

DEAR SIR: In this month's number of the Science Monthly, under the "Miscellaneous" head, you have a notice of the work now in progress for the preservation of the great glacial groove on Kelley's Island.

In that notice you speak of Prof. Wright and Dr. Sprecher as having "surveyed" the plot of land on which the groove is located. In this statement you are in error. They are *not* surveyors, and they did not survey the plot, and the suggestion of such an occupation for them must seem to those who know them very inappropriate. Prof. Wright is Professor of "New Testament Greek" at Oberlin, and the author of that noble book, The Ice Age in North America, published by the Appletons in 1890; and Dr. Sprecher is pastor of one of the largest Presbyterian churches in our city. And in that notice you make another error, which to me seems very absurd. You give my name as Young*blood*. It is not Young*blood*, as you may learn from your subscription list, where it has been recorded from the time that the first number of the Science Monthly was issued.

The facts are just these: my invitation to Prof. Wright and Dr. Sprecher to visit the island with me was wholly a matter of courtesy. While there I consulted them as to the best method of protecting the groove from the incursions of the Vandal curiosity-hunters, and also as to the best form of conveying the title, to be held in perpetuity for the benefit of science; and all of the surveying that was done by those gentlemen they did with their eyes, as they stood admiring that beautiful and wonderful work of Nature's laws.

I take pleasure in saying that I have completed the work of uncovering fifty feet of the groove, leaving fifty feet still covered to the depth of about twelve feet with clay, gravel, and fragments of the lime rock, just as it was left by Nature's laws when their work was finished, and the tools with which that work was done—granite bowlders—lie scattered over the island, and on the mainland, as far west as the Indiana line, there to rest, imperishable and unchanged, until Nature shall again take them up to do its work.

Were you to see that groove at this time I feel sure that you would pronounce it to be the most beautiful and wonderful evidence of the glacial movement that has ever been brought to the notice of civilized man.

On the 237th page of Prof. Wright's Ice Age there is an engraving which gives an imperfect view of the easterly end of the great groove, as it appeared before it was uncovered. And on the 238th page of the same book there is an engraving of another grooved rock, which is a little north of the great groove, from which I had taken off about a hundred feet before the photograph was taken, and sent to various scientific institutions. This, too, you will see is a most perfect and beautiful specimen of Nature's work.

I beg that you will pardon me for troubling you with this letter, for I feel that it is due to my friends and also to myself that the errors which I have noted should be corrected.

And, now that I have nothing further to say on the subject which prompted this letter, I will add a few words regarding The Popular Science Monthly. I have been a subscriber from the time of the issue of the first number, and I now have thirty volumes bound; and I take pleasure in saying that I think that there are no other thirty volumes to be found which contain such a vast and varied amount of useful information, or which are so well calculated to educate men in matters which advance our civilization, as those.

And more—they are a most noble monument to "Edward L. Youmans," more beautiful and enduring than marble or granite.

I am, sir, very respectfully yours,

M. C. Younglove.

Cleveland, *September* 16, 1891.

[The paragraph noticed by Mr. Younglove was compiled from a slip which was sent to the Monthly from a Cleveland paper. The language of the slip was followed, without supposing that the word "surveyed" was meant to be used in a technical sense, but rather perhaps in its original sense of looked-over, or perhaps as meaning that Drs. Wright and Sprecher had the ground surveyed. The change of our correspondent's name to Youngblood was one that we much regret; but it was also one that might naturally occur in transcription or type-setting and be overlooked by a stranger to the person concerned; for to a stranger no suggestion of error would be likely to occur.]

EDITOR'S TABLE.

THE STRONG MAN.

FORTY years ago or less the apostle of the hour was Carlyle, the fashionable gospel was the gospel of force, and the hope of the world was supposed to lie in the advent of certain heroes, strong, resolute men, who were to heal our social and other diseases by the prescriptions of a benevolent despotism. The gospel of force and all its accompanying ideas have somewhat fallen into discredit to-day. These latter times have proved very unfavorable to strong men, or at least to those who have tried to pose in that character. Louis Napoleon was a strong man: he greatly dared on a certain 2d of December just forty years ago, and for a time he seemed to be a living justification of Carlylism; but the sage of Chelsea lived to see the Man of Destiny cast down from his high pre-eminence and every vestige of his rule obliterated by an indignant people. Bismarck was a strong man, full of an almost reckless courage and utterly impatient of criticism and opposition; yet how sudden and complete was his fall! Thiers wished to play the part of the strong man in France, and so did Marshal Mc-

Mahon after him; but the country put both of them aside and passed on to policies of which they disapproved. Later Boulanger pranced across the scene in the assumed character of a savior of society; but as soon as the firm hand of lawful authority was laid on him he slunk into exile and dwindled into insignificance; finally, wrecked alike in character and estate, he sought death at his own hand. Balmaceda was another would-be strong man, and he too fills a suicide's grave. Lastly, we have Parnell, a man whose courage was indomitable, whose fortitude could not be shaken, who by the sheer force of his personality baffled the plans and confused the policies of the ablest statesmen of Great Britain; yet who, trusting to his strength to win him a personal triumph after he had violated the essential conditions of successful struggle, ended his career in failure and disgrace.

Evidently there is something wrong with the gospel of force. Heaven sends the strong men in fairly liberal supply, men who are quite prepared to fill the Carlylean requirements in the matter of doing and daring, despising small scruples and trampling on rights; but their success is short-lived, and their failure points a moral which is hardly to be found in the Carlylean philosophy. That moral is that, while strength is a good thing in itself, and courage and resolution are virtues, they need to be guided by knowledge and a careful study of conditions, if they are not to rush on to disaster. Nay, more, we see that individual strength is only weakness unless it vibrates in unison with the greater strength of true principles of action, the strength that resides in the play of great social forces. No man to-day can win any great triumph except by being in the right, and this is the great political lesson which we should strive to impress on the rising generation. To be sure, there are many false lights—mostly, however, of a minor kind—shining in the world and alluring men to a career of selfish adventure. There are men who have climbed to business or political success by means that will not bear criticism. But the examples afforded by those who have tried such means to their own ruin are more striking and impressive, if not more numerous, than any that can be quoted on the other side.

Hero-worship is well if it simply means sincere admiration for noble qualities; but it is misleading in the highest degree if it causes us to trust for great results to the action of this or that masterful individuality. To-day the "common sense of most" is the most potent factor in all social and political progress, and no man is wise who does not bear this in mind. There is ample scope still for the exercise of the highest moral and intellectual qualities, and the true hero may yet win the admiration and gratitude of society; only, what is required is that he should know the structure and laws of the society in which he lives, and seek rather to give the best expression to the tendencies of the time than to impose his own individuality on his contemporaries. Only he who, in a profound sense, obeys possesses the secret of rule.

The times are favorable, we think, for the presentation of new political ideals. Strong men of the old type, iron-handed warriors, and stern legislators, are out of date; on the other hand, the want of firmness and principle in connection with political affairs was never more conspicuous. We want a new race of strong men in whom the gamester element shall be wholly absent, and who shall aim to accomplish their ends not by personal *tours de force*, nor yet by craft and flattery, but by steady adherence to principle, and patient efforts to awaken the public to a sense of their true interests. The strong man of the future will be strong in knowledge and in social sympathy; and his strength will be spent, not in efforts to perpetuate his personal ascendency, but in efforts to develop all

that is best in the society of the time. The true strong man as we conceive him will have no greed for power; his greed, if such it may be called, will be for usefulness; and he will show his strength by his willingness to retire at any moment from a public to a private position rather than prove unfaithful to his convictions or do anything unworthy of a man of honor. Strictly speaking, a man who with adequate knowledge and intelligence tries faithfully to serve the public can never be obscure, though offices should not seek him nor caucuses make mention of his name. The public at large will recognize and honor his efforts, and his influence may be greater in a private station than that of a score of average legislators. We do not, however, look to our educational institutions to do much to develop this new type of citizen; we trust rather to general educative influences that are abroad in the world. We trust, we may say, in a considerable degree to such writings as those of Mr. Spencer, instinct as they are with noble views of liberty and of justice, and conveying at the same time clear and enlightened ideas regarding the nature and functions of the state. It is possible that private associations for the purpose of causing more intelligent views of citizenship and its duties to prevail might accomplish very good work; and we hope that something may be attempted in this way in connection with the University Extension movement which is now making so satisfactory progress. We certainly do not at this moment know of any more useful work in which an intelligent man could engage, than this of introducing a scientific element, however feeble at first, into the chaotic welter of our State and national politics.

POLITICAL JUSTICE.

It is singular what difficulty many intelligent persons experience in entertaining the idea that in a democracy there can be political injustice. "What possible means can you suggest," we are often asked, "of deciding political questions save the vote of the majority? And what ground can any one have to complain so long as he exercises the franchise with the rest? The minority can not expect to rule, can it?" These questions all proceed upon the assumption that there can not be a moral element in any political question; whereas, in point of fact, there is a moral element in every political question. If two partners were trying to arrange the terms of a separation, and each in the most shameless manner were to set at naught all considerations of equity, and strive only to get the largest possible amount out of the business for himself, we should scarcely approve of the proceeding. Every one feels that equity has something to say in such a matter. If any property whatever had to be divided, and if, instead of bringing considerations of right to bear, the parties were at once to plunge into a squabble with no guiding principle whatever save individual greed, we should think as meanly of their intelligence as of their honesty. We all feel instinctively that wherever moral principle *can* furnish a guide it *should* furnish a guide—in other words, that to decide any question without reference to moral grounds which admits of being settled on moral grounds is a gross offense against both morality and common sense. Supposing, then, that some one who had banded himself with others to carry by force a decision involving injustice to a minority—say of stockholders—should impudently say, "We had the votes and we used them"—our only conclusion would be that he was a hardy and cynical villain. Things of this kind have sometimes been done; but for the most part vice has at least paid to virtue the tribute of hypocrisy.

To bring this home to the question before us, the nation is a great corporation and the citizens are shareholders. A general election is a meeting of the

shareholders. There is an opportunity for honest and well-meaning citizens to consult and act for the benefit of the great national corporation. There is also an opportunity for others to plot and plan for their private benefit, to be secured at the cost and to the injury of the corporation. A combination may be formed to elect a corrupt directorate or executive with the expectation that it will be the submissive creature of those who invested it with power. Some will be prepared to imperil the very existence of the nation in order that they may carry certain selfish purposes of their own into effect. Thus every general election and, indeed, every phase of political action affords an opportunity for the practice of political justice or of political injustice; and to say that any particular determination of the electors or of a legislative body is just because it commanded a majority of votes is as absurd as to say that in a physical encounter right must rest with the conqueror.

"What are you going to do about it," say some, "if the people manifest a complete indifference to these considerations?" We can do nothing about it, we reply, but uphold the true principle, and trust that the apparent "foolishness of preaching" may in the end prove wiser than the wisdom of our practical politicians who wield votes precisely as they might wield clubs. It is all a question of the moral growth of the people; and we can not but hope that the time will come when even the average citizen will understand that right is not *made* by majorities, but that majorities are happy when they are able to discover what right is, and pay it the homage of their support.

TRAMP COLONIES.

There appears to be an epidemic of schemes for reforming shiftless people by wholesale. The latest reported is a proposal by a Mr. Heller, of Newark, N. J., to establish seven colonies, in as many States, for the benefit of old and unemployed people and tramps. The chief feature of the scheme is to be the reformation of tramps. Work is to be provided for those who will work, and Mr. Heller evidently expects that a large part of them will. He doubtless actually believes what the tramps say of themselves, and accepts the familiar "can't get work" whine for absolute truth. This belief is squarely contradicted by well-known facts. Plenty of work can be had now, without any colony machinery, by those who will work. During the past summer workers have been called for all over the United States, to gather in this year's bountiful harvest. No tramp could extend his travels to twenty miles outside any large city without coming across farmers who would be glad to give him fifteen or twenty dollars a month and board for faithful work. In a recent book on Crime and its Causes, the author, William Douglas Morrison, who is an English prison official, puts the number of vagrants who are willing to work at not much over two per cent. To confirm his view he quotes the following striking testimony from M. Monod of the Ministry of the Interior in France:

According to M. Monod, a benevolently disposed French citizen wished to know the amount of truth contained in the complaints of sturdy beggars that they were willing to work if they could get anything to do or any one to employ them. This gentleman entered into negotiations with some merchants and manufacturers, and induced them to offer work at the rate of four francs [eighty cents] a day to every person presenting himself furnished with a letter of recommendation from him. In eight months seven hundred and twenty-seven sturdy beggars came under his notice, all complaining that they had no work. Each of them was asked to come the following day to receive a letter which would enable him to get employment at four francs a day in an industrial establishment. More than one half (four hundred and fifteen) never came for the letter; a good many others (one hundred and thirty-eight) returned for the letter but never presented it. Others who did present their letter worked half a day, demanded two francs,

and were seen no more. A few worked a whole day and then disappeared. In short, out of the whole seven hundred and twenty-seven, only eighteen were found at work at the end of the third day. As a result of this experiment M. Monod concludes that not more than one able-bodied beggar in forty is inclined to work even if he is offered a fair remuneration for his services.

The idea of forming a community with such material for its citizens is absurd in the extreme. The tramp will not work so long as he can find soft hearted and softer headed people who will give him a subsistence in idleness. These self-satisfied charitable persons, who give indiscriminately to save themselves the trouble of helping judiciously, really entice more unfortunates into beggary than they raise out of it.

LITERARY NOTICES.

Evolution in Science and Art. Lectures and Discussions before the Brooklyn Ethical Association. New York: D. Appleton & Co.

The topics considered in these lectures include not only the special unfolding of each branch of science, but also sketches of the leading evolutionists and outlines of their methods. The first of the series is a concise and excellent review of *A. R. Wallace* and his work, by Prof. E. D. Cope. The co-author with Darwin of the theory of natural selection is honored as a biologist, not for researches in anatomy or paleontology, but for his mastery of hexicology—the study of the mutual relations of living objects. Extensive travel for twelve years in the tropics furnished him with a storehouse of zoölogical facts. From these resulted various papers on birds' nests, protective coloration, and mimicry; while the theory of natural selection was drawn from his observation of the variations of species. Besides his works on evolution, he has written books of travel and essays on political economy. Prof. Cope regards Dr. Wallace as a fine example of his own doctrine, that all force is will-force, and pays another tribute to him as typical of the intelligent spirit of this century, determined to know and to use the knowledge for the benefit of mankind. His explanation of force and intelligence, as caused by an influx of spirit, is deemed, however, "an unnecessary interjection in an otherwise continuous operation of known and unknown causes."

As Dr. Wallace is so stanch a supporter of the theory that variations are congenital and environment a secondary feature, while Prof. Cope holds as firmly to the opposite view, several mooted points are discussed *en passant*, and in conclusion a synopsis is given of the respective tenets of the Neo-Lamarckian and Neo-Darwinian schools.

The famous zoölogist and author of monism, Prof. *Ernst Haeckel*, is the theme of the second lecture, by Thaddeus B. Wakeman. The life and enthusiastic labors of the great naturalist are fascinating subjects. Whether studying at "dear Jena," or diving in the Indian Ocean, or waging war with Prof. Virchow, his zest for knowledge is unappeasable and magnetizes his followers. His wonderful industry has given to the world nearly a dozen valuable zoölogical works and several charming books of travel. It is his philosophy or religion, however, that especially attracts his biographer. Mr. Wakeman is consumed by a monistic fervor; and it is questionable whether, in his anxiety to rid the universe of "spooks," he does not create some for iconoclastic purposes. The "unknowable" of Herbert Spencer, or Prof. Huxley's limitations of knowledge, need some endowment of objectivity before they can be properly exorcised as wraiths.

The Scientific Method is expounded by Dr. Francis E. Abbot in the third lecture. This, when tersely stated, consists of observation, hypothesis, and verification. A confirmed transcendentalist might oppose the first step by questioning whether one could observe an external world. So the lecturer gives an imaginary controversy between the realist and consistent idealist, and finally drives the latter logically into the corner of solipsism, where he is made to declare that the universe is within himself. The actual idealist always escapes this fate by allowing an inference of the objective which we can not know *per se*. As the idealistic individual shut up with himself can not know, so he can not add to human knowledge. The

scientific man, on the other hand, recognizes an external world and positive knowledge, and seeks to contribute some new grain of truth if he may. He observes, hypothesizes, and verifies, and finally submits his result to verification by the race, the ultimate criterion being *the unanimous consensus of the competent.*

Notwithstanding Dr. Abbot's clear statement of the scientific method, this final standard of knowledge seems ambiguous. The truth of a theory needs no further test than its complete verification by *all* the facts to which it applies.

To make a synopsis of the *Synthetic Philosophy* of Herbert Spencer intelligible within the limits of a lecture is a difficult task, which Mr. B. F. Underwood has accomplished extremely well. Not only this, but he has given an introductory analysis of the opposing philosophical systems which preceded the evolution hypothesis. The sensation philosophy of Locke and Hume, and the *a priori* speculations of Kant, representing hoary antagonisms of thought, were by Spencer's insight found to be different halves of the whole truth that knowledge is derived from experience, but the experience of the race furnishes innate ideas to the individual. Spencer's doctrine that we perceive only phenomena, and from these infer the noumenal existence which causes changes in consciousness, is known as transfigured realism; and, though charged with idealistic leaning by rank realists, is no more transcendental than the views of Dr. Maudsley and Prof. Huxley. According to the latter, "all phenomena are, in their ultimate analysis, known to us only as facts of consciousness." But it is the "unknowable reality" which proves a stumbling-block to many. Theologians dislike this, since it excludes a knowledge of God, and the scientific are afraid of it because Unknowable is printed with a capital, which suggests another sort of deity. Disciples of Haeckel vainly impute dualism to Mr. Spencer, while he declares, "I recognize no forces within the organism or without the organism but the variously conditional modes of the universal immanent force." Whatever chiseling time may effect in the body of Spencer's doctrine, there is good reason to believe with Mr. Underwood that the leading principles will remain intact.

In the *Evolution of Chemistry*, Dr. R. G. Eccles has skillfully traced the growth of chemical knowledge from the vague theories of the ancients to the definite, complex science of to-day. After the time of Aristotle the elemental theory or doctrine of abstract qualities saturated thought for fifteen hundred years. The scales first used by the young Scotch chemist Black weighed scholastic dogma as well as fixed air, and proved the hollowness of *a priori* reasoning. This step in verification made progress possible. Oxygen was discovered by Priestley, combustion explained by Lavoisier, and the law of definite and multiple proportions ascertained by Dalton. The idea of continuous matter was displaced by the atomic theory, and Avogadro's law regarding the volume of gases confirmed the hypothesis. The laws of specific heat, crystallography, and Mendelejeff's formula, each added its proof of atomic weight. The study of the coherence of groups of atoms resulted in the wonderful synthetic productions of the laboratory. The brilliant dyes, flavorings, perfumes, and medicines made by the chemist excelled those offered by Nature, and utilized hitherto waste products. Although the detail of organic chemistry is now beyond the mastery of any man, the outlook is infinite, and problems whose solution promises the secret of creation itself tempt the student. The composition of the ferments, pepsin and trypsin, or of the albuminoids, and the conversion of starch into cane sugar, would unlock incalculable benefits. The author considers the development of chemical knowledge, like the habits of atoms, closely illustrative of evolutionary law.

Thales suggested electricity as a condition of life, and the author of *The Evolution of Electric and Magnetic Physics* is inclined to agree with him. According to Mr. Kennelly, "it is possible, if it is not at present demonstrated, that electricity may be the active principle in the processes of animal vitality; . . . the relation between electricity and vitality may be so close as to amount to identity." This is perhaps pardonable in the chief electrician of Edison's laboratory, but it is doubtful if any eminent physiologist or psychologist will allow that nerve-fibers do more than artificially

resemble insulated wires, or that a dynamo can confer any degree of immortality. The growth of electric knowledge is recent; for twenty-two hundred years it was dormant. The seventeenth century witnessed investigation of electrical phenomena and of the properties of magnets, but for two centuries thereafter no connection was realized between them. It was only after Oersted's discovery, in 1820, that a magnetic needle is deflected by the electric current, that electro-magnetism became a science. Its subsequent progress was correspondingly rapid, and its offspring are the crowning inventions of to-day. Three propositions are especially emphasized by Mr. Kennelly: 1. All electricity tends to flow in closed curves or circuits. 2. The conductivity of the surrounding ether. 3. The production of light by electro-magnetic vibration.

The development of botany and the brilliant progress of electricity are as unlike as a flower and an electric spark. In his lecture upon the *Evolution of Botany*, Mr. Wulling shows that the accumulation of botanic knowledge was nearly as gradual as vegetable growth. The primitive needs were food and clothing, and an acquaintance with plants supplied these. Herbs were also found to be noxious or healing, and skill in remedies was sought and venerated in the early ages. In time so many species were described that various attempts were made to classify them, and at length the natural system of Jussieu prevailed. Investigation of the structure and anatomy of plants followed the introduction of the microscope. The establishment of botanical gardens facilitated the study of foreign flora; plant morphology and physiology were differentiated as branches of research; and, finally, geological, paleontological, and pathological botany constituted separate departments of this complex science. Mr. Wulling refers to the labors of many American botanists, and applies the formula of evolution to an analysis of botanical history.

Each of the foregoing lectures is preceded by a list of collateral readings useful to the student, and followed by a brief discussion of the subject by members of the Ethical Association.

The Natural History of Man, and the Rise and Progress of Philosophy. By Alexander Kinmont. Philadelphia: J. B. Lippincott Company. Pp. 335. Price, $1.

This book comprises a series of lectures that were delivered and first published fifty years ago, or before the present methods of investigation were instituted, and before the existing theories of development had begun to prevail. Yet it is not antiquated, and the claim of the editor is supported that "the rapid movement of the world in all departments of thought, the changes of opinion and sentiment in doctrinal theology, and in philosophy, have not distanced nor superseded the ideas herein presented." The author regards the study of anthropology as chiefly valuable as an introduction to the science of Deity, and tries whether he can not trace in man, "the image and likeness" of God, "some of the more majestic elements of the original." He does not attempt any formal science of human nature, or any theory which might deserve the name of anthropology, "for such theory or perfect science, I imagine, would be premature still, by many hundreds of centuries." Yet, while he approaches the subject from a wholly different point of view than that from which contemporary philosophers regard it, and considers a different side of it, his thoughts lead him in the same direction as they take, and his work presents many foreshadowings of the doctrine of evolution. He might be described as a theological anthropologist. In the lecture on the origin and use of language he says that "the arguments drawn from the sacred scriptures, to establish a system of uniform sounds and modifications of voice to designate ideas, are of a kin with the systems of astronomy and geology drawn from the same book; all of which, after being fanatically maintained for a time by arguments supported by passion rather than philosophy, are compelled by degrees to give place to the solid truths of observation and experience." Not that anything in science militates against the authority of the scriptures; "but these books do not purport to deliver to us a system of science, but only to reveal the Author of Creation, and the established series of its epochs." Thus in the accounts of events, as in that of the creation, the statements are to be interpreted, not in the literal,

physical sense, but as condensed, emphatic utterances of the theological truth—in this case of God the Creator—which in the mind of the author predominates over the scientific truth. The labors of modern geologists do not affect the truths, before announced, in regard to the creation of the world, for the simple reason that they refer not to the workman, but to the physical characters of the work. "This distinction now begins to be understood, and will be so more and more, as the truths of religion and the truths of science are seen to be of different orders, sometimes apparently blended, but never actually confounded. . . . Three thousand years ago or upward, Theology in the Eastern world stood unconfounded with science, and men heard from her, and were satisfied with the response; that 'in the beginning God created the heaven and the earth'—that 'God said, Let there be light, and there was light'; and they heard the number of the days of creation also, and were satisfied; and similarly, in our times, it may be affirmed that Science stands on her own ground, unoccupied by theology, and expounds facts and establishes conclusions, no longer fearing or being feared; and men are now, in regard to science, what they used to be in regard to religion—free and unembarrassed, serving but one master. And this is the more worthy of observation when we recollect the history of the intervening period—how science has been confounded with religion, and religion with science, to the detriment and dishonor of both. . . . It is only when each pursues that order and series of truths which are peculiar to each that any mutual benefit can arise; but, when they encroach on each other's provinces, the most baleful effects ensue." The presentation of this branch of the subject, and the chapters on The Origin and Perpetuation of the Natural Races of Mankind, and Unity in Variety of the Human Race, are followed by studies of certain particular nationalities.

An Introduction to Natural Philosophy. By Denison Olmsted, LL. D. Fourth revised edition, by Samuel Sheldon, Ph. D. New York: The Baker & Taylor Company. Pp. 465. Price, $2.75.

It is nearly half a century since Olmsted's Philosophy was first published, and although the progress of modern knowledge in this period has made four revisions necessary, the name and plan of the author are still deemed worthy of being retained. For the present revision the whole book has been carefully gone over, the chief efforts of the editor being spent in rewriting the parts treating of Electricity and Magnetism. The subjects Force, Energy, Work, Wave-motions, Organ-pipes, Spectrum Analysis, and Interference of Light-waves have also been almost entirely rewritten. Extended description of apparatus has been avoided. A few striking experiments have been described, but the choice of demonstration has been left largely to the instructor. Many new drawings, chiefly in outline, have been made. The work is adapted to college students. It would be improved by the addition of an alphabetical index.

The *Chapters on Electricity*, written by Prof. *Samuel Sheldon* for the above treatise, are also published separately (Baker & Taylor Company, $1.25). This volume is intended for use in those colleges which devote but thirty or forty hours to the subject, and the principles presented in it are those which the author thinks every liberally educated person should know. It has been the desire of the author to present each part of the subject in its most modern dress. This desire, however, has been tempered by a consideration of the intended functions of the book.

Chemistry of the Carbon Compounds, or Organic Chemistry. By Victor von Richter. Authorized translation by Edgar F. Smith. Second American from the sixth German edition. Philadelphia: P. Blakiston, Son & Co. Pp. 1040. Price, $3.

This work is sufficiently detailed to meet the wants of advanced students of organic chemistry, and to serve as a reference-book for practical chemists. The present edition differs considerably in its arrangement and size from the first edition. The introduction contains added matter upon analysis, the determination of molecular weights, recent theories on chemical structure, electric conductivity, etc. The section devoted to the carbohydrates has been entirely rewritten, and presents the most recent views in regard to their constitution. The sections relating to the trimethylene, tetramethylene, and penta-

methylene series, the furfurane, pyrrol, and thiophene derivatives, have been greatly enlarged, while subsequent chapters, devoted to the discussion of the aromatic compounds, are quite exhaustive in their treatment of special and important groups. The translator has had the hearty co-operation of the author in preparing this edition.

Topics of the Times. By Rev. Howard MacQueary, Author of The Evolution of Man and Christianity. New York: United States Book Co. Pp. 238 + 51.

In this book the Rev. Howard MacQueary shows that he is interested in and capable of discussing other than theological questions, for here he addresses himself to the vital questions of the times, in which a larger public will be interested than even the large one which has read his former book. This work is divided into two parts, the former consisting of Lectures on the Conflict between Labor and Capital; An Exposition of Nationalism; Truths and Errors of Henry George's Views; The Savages of Civilization; Popular Ideas of Poverty; Reduction of Hours of Labor; The Negro in America; The Bible in the Public Schools. The second part contains ten sermons, many of them on most important and interesting topics: Our Country: its Character and Destiny; The Sabbath Question; Criticism of the Bible; Did the Fish swallow Jonah? What's the Use of Praying? What is the Evidence of Life after Death? The God-filled Man; Unshaken Beliefs; Should we have Creeds? The Real Rights of Woman.

In his preface Mr. MacQueary defends the pulpit for undertaking the discussion of Topics of the Times. There are, he says, two radically different ideas of the Church and the pulpit. Some regard the clergyman as a sort of religious policeman whose duty it is to hold up before sinners pictures of hell to scare them into doing their duty. Others, however, hold that the Church and the pulpit have to do with the moral aspect of every question, political, social, or scientific, and that Religion and Morality are twin sisters. This latter point of view is justified by the example of the prophets of Israel, who denounced the social and political evils of their time. With regard to the papers in the book, the author says that they "are intended to be popular discussions of the great problems considered," but not to be "exhaustive or original." He has evidently succeeded in "casting the material in his own mold," as he claims to have done.

The reader of these papers will find them very interesting, stimulating to thought, and helpful to all to whom the burning questions of the day are serious problems. The author has brought to his task wide reading, an earnest consideration of the subjects treated, and an easy and agreeable style. The views of Henry George receive a pretty thorough treatment, and the paper on the Savages of Civilization is of thrilling interest.

There has been added to the lectures and sermons a paper on ecclesiastical liberty, which is the able defense of Mr. MacQueary before the ecclesiastical court of the Episcopal Church of the Northern District of Ohio against the charges of heresy. This paper is of permanent interest, although the case has now at length been definitely settled by Mr. MacQueary's withdrawal from the Episcopal Church.

The Right Hand; Left-Handedness. By Sir Daniel Wilson. London and New York: Macmillan & Co. Pp. 215. Price, $1.25.

This treatise includes data originally accumulated in a series of papers communicated to scientific institutions in Canada, in which the author sought to determine the cause of left-handedness by a review of its history in its archæological, philological, and physiological aspects. To these, results of later investigation have been added; and besides the effort to trace left-handedness to its true source, the folly of persistently trying to repress an innate faculty of exceptional attitude, and the advantages to be derived from the systematic cultivation of dexterity in both hands, are insisted upon. In the former chapters of the book—on "the educated hand," "the willing hand," "palæolithic dexterity," etc.—the prevalence of right-handedness is shown to have been marked from the earliest and even the prehistoric ages of mankind. Its manifestation in children appears by the weight of evidence to be often spontaneous. The structure of primitive implements, ancient weapons, etc., shows it to have been the rule through the historical period. Philological arguments, references in ancient literature to right-handed-

ness, and to left-handed exceptions, the writing of ancient documents, and the positions of the figures in drawings, bear in the same direction. Consideration of these evidences precludes the idea of the origin of right-handedness lying in any ancient custom, or of its development and enforcement by education into a nearly universal habit. The conclusion is therefore inevitably forced on the inquirer that the bias in which this law originates must be traceable to some specialty of organic structure. This argument becomes stronger when we reflect that right or left handedness is not limited to the hand, but partially affects the lower limbs, as may be seen in foot-ball, skating, the training of opera-dancers, etc., so that eminent anatomists and physiologists have affirmed the existence of a greater development throughout the whole right side of the body. Theories have been proposed assuming stronger circulation, visceral predominance, or more vigorous muscular growth on the right side, but they do not seem to go to the root of the matter; while the theory of cerebral localizations on which many other human faculties have been found to depend seems more ample. It is understood that each hemisphere of the brain affects the opposite side of the body. In the majority of cases where the hemispheres have been weighed separately, the left hemisphere has been found heaviest. This would give predominance to the right side In the case of a single left-handed patient, Dr. Wilson and an associated physician found the right hemisphere to weigh the most. "No comprehensive indications can be based on a single case, but its confirmatory value is unmistakable at this stage of the inquiry; and thus far it sustains the conditions previously arrived at."

Laboratory Practice. A Series of Experiments on the Fundamental Principles of Chemistry. By Josiah Parsons Cooke, LL. D. New York: D. Appleton & Co. Pp. 193. Price, $1.

Teachers who are striving against many obstacles to teach science according to its own proper method will be glad of the help which the senior Professor of Chemistry in Harvard College offers them through this volume. It is a manual of directions for experiments in which especial care is taken that what the experiments teach shall not be lost sight of. "The student should be given to understand clearly," says Prof. Cooke in his introduction, "that experiments performed mechanically, without intelligence, or carelessly recorded, are worth absolutely nothing, and should be so estimated in any system of school or college credits." This book is designed as a companion to The New Chemistry, by the same author, which contains no experiments for the student, as the present volume contains no extended statement of chemical principles. The principle that each experiment illustrates, however, is indicated by a heading, and in many cases the conclusions that the teacher should enforce are explicitly stated. Notes, questions, and problems are also inserted after each experiment or group of experiments, in order to direct the student's attention upon the essential features of the investigation in hand. Ample cautions accompany all experiments that would be dangerous if carelessly performed. The present issue of this manual has the value of a revised edition, for the book is an enlargement of a list of experiments printed in pamphlet form that has been used for several years in Harvard College and in a number of fitting schools. In order to make the expense less of an obstacle to the performance of these experiments by school classes, the author has sought to adapt to the purposes of instruction common household utensils, such as may be made by a tinsmith or found at any house-furnishing store. Two figures of a kerosene stove applied to laboratory purposes are given, and many other definite suggestions in regard to apparatus are furnished.

By the publication of Part IV, Dr. *Michael Foster*, F. R. S., has completed the fifth edition of his *Text-book of Physiology* (Macmillan, $1.90). This part comprises the conclusion of Book III, on the Central Nervous System and its Instruments, and Book IV, on the Tissues and Mechanisms of Reproduction. There is also an Appendix on The Chemical Basis of the Animal Body. In the portion of Book III here presented the special senses and the voice are briefly treated, and the account of reproduction is also brief. A little more than two hundred pages are given to the topics here enumerated, bringing the whole

number of the pages in the work up to 1,356. The author hopes to begin the publication of a sixth and carefully revised edition of the whole book early in the autumn. We would suggest that he add an index to the forthcoming edition.

Muter's Manual of Analytical Chemistry, several previous editions of which we have noticed, now appears, revised by an American editor, Dr. *Claude C. Hamilton*. This revision is based on the fourth English edition. The editor has made only such changes as were required to adapt the book to the United States Pharmacopœia except in the chapter on urine analysis, which has been enlarged, and to which cuts of microscopic sediments and other illustrations have been added. The chapter on water analysis has been altered to correspond with Wanklyn's methods, as those are most generally used in America. Several other processes have been added, such as estimation of chloral hydrate, of fat in milk, etc., and various minor changes in arrangement have been made in the interest of convenience in using the treatise.

A volume of *Elementary Lessons in Heat, Light, and Sound* has been prepared by Prof. *D. E. Jones* (Macmillan, 70 cents). It is an experimental book, intended for beginners, and aims to bring out "one of the chief advantages of science as an educational subject—the training in the habit of observation, and of learning from things at first hand." In the methods of reasoning, as well as in the choice of words and subject-matter, the author has endeavored to be as simple and clear as possible. He has also repeatedly tried and modified each experiment so as to present it in a simple form, and avoid the more usual causes of failure. The book is illustrated.

Part III of the *Short Course of Experiments in Physical Measurements*, by *Harold Whiting* (D. C. Heath & Co., $1.20), deals with principles and methods. About half of its three hundred pages are devoted to some fifty tables, and notes on their arrangement and use. This material is preceded by ten chapters, in some of which such matters as Observation and Error, and Reduction of Results are treated, while the others deal respectively with the several departments of physics.

A pamphlet is before us entitled *The Universe and its Evolution*, being a translated abridgment of a five-volume work in Hebrew, by *S. J. Silberstein*. The author denies the law of gravitation, and asserts that Kepler's laws not only are not explained by it, but furnish evidence against it. He brings forward many arguments to show that the planets could not have been projected from the sun into their present orbits. He maintains, further, that they could not continue their revolutions indefinitely, for the attraction of the sun would draw them in upon that body, unless, as he affirms, motion begets motion. In another chapter some of Spinoza's ideas of God are combated, and the author then unfolds his conception of the universe. He considers the source of all to be the Absolute Intellect, whose offspring, the absolute essence, brought the atoms into existence, and the atoms are controlled by a force that he calls "centrality." This force resides in the center of every body, and maintains the character of the body. Several other physical laws are laid down, and the larger work is referred to for a full statement in regard to them. The author apparently has not considered the modern nebular theory.

The revision of *The Chemical Analysis of Iron* (Lippincott, $4) that has just been made by the author, *Andrew A. Blair*, has consisted in the correction of mistakes that were apparent in the first edition, and the adding of matter called for by the advance in analytical chemistry during the past three years. The Table of Atomic Weights has been revised, and the Table of Factors has been changed to correspond to the new values.

A report on *The Pediculi and Mallophaga affecting Man and the Lower Animals*, by Prof. *Herbert Osborn*, has been issued as a bulletin of the Department of Agriculture. It describes the various kinds of lice found on man, the monkey, dog, goat, ox, hog, horse, the rodents, poultry, and various other animals, giving illustrations of forty-three species.

A pamphlet made up of *Original Communications of the Zymotechnic Institute* has been published by the director, Mr. *J. E. Siebel* (242 Burling Street, Chicago). The papers are reports of scientific investigations into a variety of matters connected with the brewing industry, such as the composition of the

acrospire of barley, yield of material in the brewery, differentiation of subterranean water-supplies, etc. There are six plates, showing different kinds of bacteria, of saccharomyces, molds, and starch, microscopic aquatic life, and forced beer sediments.

An *Address on the University Extension Movement*, delivered by *Richard G. Moulton*, A. M., has been published by the American Society for the Extension of University Teaching (1602 Chestnut Street, Philadelphia). Mr. Moulton defines university extension as "university education for the whole nation organized upon itinerant lines." He says that university education differs from school education in being unlimited, and that a university fails miserably in its duty if it does not give one those tastes and those mental habits which will lead him to go on learning to the end of his days. Not every person will get the same thing out of university instruction. Each helps himself according to his own capacity. The extension teaching involves lectures, class-work, printed syllabuses, weekly written exercises, examinations, and certificates. The interest that has been aroused in England is shown by the written exercises voluntarily sent in, changes in the character of the demands on the public libraries and of the conversation at social gatherings, traceable to courses of lectures, and similar indications Mr. Moulton speaks of university extension as a missionary movement, and urges all who possess the benefits of culture to assist in giving culture to others.

The Iowa State Medical Society has begun the publication of a bimonthly magazine, *The Vis Medicatrix*, which will serve as the journal of the society (Des Moines, $1 a year). It is edited by *Woods Hutchinson*, M. D., and the first number contains the proceedings at the society's fortieth annual session, the president's address, departments devoted to diseases of animals, plant diseases, medical colleges, notes and news, etc.

Mr. *John A. Wright*, of Philadelphia, has published a pamphlet on *The Practical Working and Results of the Inter-State Commerce Act*, the purpose of which is to present (1) the law of distribution of the returns on all products that require transportation to a market; (2) the policy of transporters in view of their duties as common carriers; (3) the difficulty of estimating the cost of transportation; (4) a measure on which a just rate of profit on the stock of transportation companies may be based. The author points out provisions in the law which he holds should be expunged as impracticable and dangerous.

A treatise on *The Principles of Agriculture* has been prepared for common schools by Mr. *I. O. Winslow*, and is published by the American Book Company. It regards a knowledge of the subject as identical with a knowledge of the natural laws and principles that underlie rural life and rural pursuits, and considers it an important element in the education of the young. Hence it begins at the foundation with descriptions of the substances of the earth, accounts of its geological history, and the leading facts and principles of the several sciences that bear directly on agriculture and rural life. The applications of the principles are then described in the chapters on Plants, Fertilizers, Cultivation, and Animals. Minor and subordinate topics are omitted, in the belief that a thorough knowledge of the few main points is worth more to the pupil than a confused idea of the whole. Points not definitely settled are avoided, or mentioned only briefly. The book is designed, primarily, for use in the public schools, and contains no difficulties too great for ordinary pupils of twelve or fourteen years.

A text-book on the *Elements of Civil Government*, published by the American Book Company, has been prepared by *Alex. L. Peterman* for use in schools, and as a manual of reference for teachers. It is intended to supply what is a serious want in many of our schools, which omit instruction concerning civil government and the science of citizenship. It begins with the family, the first form of government with which the child comes in contact. As his acquaintance with rightful authority increases, the school, the civil district, the township, the county, the State, and the United States are taken up in their order. In each case the nature and purposes of the Government are explained, and its scope and methods. The author endeavors to present the subject in a simple and attractive way.

In a curious book entitled *Beyond the Bourn* (Fords, Howard & Hulbert), Mr. *Amos*

K. Fiske records a dream of the future world, and expounds his views on the destiny of man. The fiction is sustained of a person who was rendered insensible and to all appearances dead for three days by a railroad accident, and whose spirit sojourned in the other world for that time. Recalled to life and earth, he feels himself a stranger among those who were of his kind, and is impelled to leave a record of his experiences and impressions in the abode of spirits. Hints are given of the persistence of the principle of evolution throughout the universe, and of the continued development and perfection of the human race in the after-life.

A collection of the Rev. Henry Ward Beecher's patriotic addresses, compiled a few years ago by Mr. *John R. Howard*, contained a review of Mr. Beecher's Personality and Influence in Public Affairs. This is now separated from the original volume by the author, and published by itself, by Fords, Howard & Hulbert, under the title of *Henry Ward Beecher: a Study of his Personality, Career, and Influence in Public Affairs.* It is, in fact, an interesting and critical biography of a man whose influence on American thought and political tendencies has been second to that of few if any others. The book is embellished with excellent portraits of Mr. Beecher at forty-three, at sixty-five, and at seventy-three.

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POPULAR MISCELLANY.

Association of Official Geologists.—The preliminary steps were taken at Washington during the meetings of the International Geological Congress toward the formation of an official organization of the directors of State and national geological surveys. The more important objects of the projected society are the determination of the proper objects of public geologic work, the improvement and unification of methods, the establishment of the proper relative spheres and functions of national and State surveys, co-operation in works of common interest and the prevention of duplication of work, the elevation of the standard of public geologic work and the sustenance of an appreciation of its value, and the inauguration of surveys by States not having any now, which co-operate with the other State surveys and with the national survey.

Changes in Level of the Atlantic Coast.—The fluctuations in height of the Atlantic lowland coast-lands of the United States were described by Prof. W J McGee in a paper read before the American Association. In the Pleistocene period the land stood between three hundred and eight hundred feet below its present level. Immediately afterward the land rose to from three hundred to six hundred feet above its present height, and the shores of the Atlantic and the Gulf retreated to from one hundred to five hundred miles beyond their present position. Afterward the land gradually sank, and the waters readvanced until the geography was much the same as to-day. Then came another incursion of the ocean and gulf, bringing sea-waters over nearly all the area upon which Washington is built, and over considerable portions of the North and the South. During this period there was deposited a series of loams and brick-clay and bowlder-beds, upon which Washington is located, and which has been named, from the District, the Columbia formation. At the close of the Columbia period the land again rose one hundred or two hundred feet higher than at present, and river channels were cut from fifty to seventy-five miles beyond the present coast-line. It then began to sink, and this movement is yet in progress.

South American Railroads.—Three of the railroads that start from the Pacific coast of South America and run up the valleys of the Andes, says President Gardner G. Hubbard, in his address to the National Geographic Society, are among the most remarkable roads in the world, ascend to a greater elevation than any others, and reach a height which in Europe and the United States would be above the snow-level. They were intended to reach the gold and silver mines between the Andes and Cordilleras. The first, called the Oroya or Central Railroad, one hundred and eleven miles long, starts from Callao and crosses the Andes at an elevation of nearly fifteen thousand feet. It is intended to extend it to the navigable waters of the Amazon. Three hundred miles southward of this, the second road runs from Mollendo, Peru, by Arequipa to Puno or Lake Titicaca, and thence northward on the plateau four hundred and seven miles to San Rosas, on the route to Cuzco. For a part of the way it runs through a country so destitute of water that the only supply for the engines and stations is by an iron pipe eight inches in diameter and fifty miles long, running from an elevation of seven thousand feet to the sea-coast. Seven or eight hundred miles south of Mollendo a line runs from Valparaiso, in Chili, to Buenos Ayres, eight hundred and seventy miles. It crosses the Andes through a tunnel two miles long, at an elevation of ten thousand five hundred and sixty-eight feet above the sea; after leaving the mountains it runs over the pampas two hundred miles, without a curve or a grade more than three feet above or below the plain, and will soon be completed from ocean to ocean. From Rio Janeiro several roads have been constructed over the mountains west of that city to different parts of Brazil. There are now from six thousand to seven thousand miles of road in operation in the Argentine Republic, five thousand or six thousand in Brazil, and three thousand or four thousand miles in the other states, making a total of about fifteen thousand miles of railroad in operation. The apparently most feasible route for the proposed Pan-American Railroad to run from the Caribbean Sea to the Argentine Republic, and to connect with the others, starts from Cartagena, follows the valley of

the Magdalena River eight hundred miles to Dividal, seventeen hundred feet above the sea; crosses the eastern Cordilleras at an elevation of about six thousand five hundred feet to the head-waters of the Caqueta or Yapura, a branch of the Amazon, and runs down that river three hundred and seventy-five miles to the mouth of the Engarros, five hundred and fifty feet above tide-water. From the Caqueta River the route passes through Ecuador to Iquitos, Peru, crossing fourteen tributaries of the Amazon. From Iquitos it ascends the Amazon and the Ucayle five hundred miles to Napal, thence continues across the Montaña, and the numerous valleys of the Amazon about six hundred miles, to Santa Cruz in Bolivia, or twenty-four hundred miles from Cartagena; while a branch will run up the Apurimac to Cuzco. This road would run for two thousand miles along the foot-hills of the Cordilleras, in which is probably the richest mining region in the world, and would greatly facilitate the opening and working of the mines. It would cross many branches of the Amazon, and thus connect with fifty thousand miles of navigable waters, at least nine thousand of which are above Iquitos, and it is claimed that the business from twenty thousand miles of navigable waters would find by this route a nearer outlet to Europe and American markets than by Pará. There is every variety of climate on the route; and the country, under a wise government, is capable of sustaining an immense population and giving abundant support to a railroad.

Purification of Sewage.—The method of purifying sewage at Worcester, Mass., by chemical precipitation was described by Prof. L. P. Kinnicutt at the meeting of the American Association. The sewage treated contains a notably large quantity of the waste products of various manufacturing establishments, and an unusually large amount of free acids and iron salts. The Carpenter process is employed for purification. By adding lime and the crude sulphate of aluminum the suspended matter is all removed and the total organic matter is reduced over two thirds. The effluent water is clear and colorless, without odor, and with only a slight alkaline taste, and can cause no nuisance when run into a stream of not more than five times its volume. The precipitate, or sludge, is free from bad odor, and when dried contains nearly sixty per cent of iron oxide, ten per cent of carbon, thirteen per cent of nitrogen, and four per cent of phosphoric acid. Its theoretical value is about forty-five dollars per ton. If no use is found for it, it can be disposed of by burning.

Evolution of Clocks and Watches.—The beginning of modern clock-making may be dated from 1656, when Huygens attached the pendulum to the clock. This gave horology a place in the exact sciences such as it had not before held. The next important advance was the invention of the watch balance-spring, by Dr. Robert Hooke, of the Isle of Wight. He was the author of other valuable inventions and improvements, among them the "anchor" escapement and some ingenious tools for the making of astronomical instruments. Previous to 1691 watches had only the hour-hand. Daniel Quare, of London, added the minute-hand. Nine years later the horizontal escapement in its perfect state was made public by George Graham, F. R. S., and the device of jeweling the parts most subject to wear was introduced into England by M. Facio, of Geneva. The English Government commission on a method of finding the longitude, of which Sir Isaac Newton was a member, appointed in 1714, published the conclusion that an accurate time-keeper would furnish the best means; and an offer was made by the Government for the discovery of a method—fixed at £10,000, if by it the longitude could be defined to one degree; £15,000, if within two thirds of a degree; and £20,000, if within half a degree. John Harrison, born at Foulby, near Pontefract, in Yorkshire, in 1693, who devised the gridiron compensation pendulum, was stimulated by the offer to efforts to find a similar regulator for a watch, and devised an automatic regulator which Halley thought might prove to be of some value. He applied it to a time-keeper, which, having stood a test in a boat on the Humber, was successfully taken to Lisbon. The Board of Longitude advanced him £500. A second instrument was not satisfactory to the board; but a third won for the inventor the gold medal of the Royal Society. This instrument was sent on a long voyage to Jamaica. After

being eighteen days out, a difference of more than two degrees appeared between its indications and the shipmen's calculations. Harrison insisted that his time-piece was right, and told the shipmen that, if they turned in a certain direction, they would sight a certain island the next morning—if the maps were right. They did so, and the island was seen, according to his prediction. Like results were obtained as island after island was passed. On arriving at Port Royal, after a voyage of two months, the time-keeper was five seconds slow; and on returning to England, after five months, its error was less than a minute and a quarter. Harrison was not allowed the offered reward till more sure tests were made, but was given £5,000. The watch was tested on a second voyage, with triple precautions, and Harrison was allowed £5,000 more, and promised the rest of the £20,000 when he had taught others how to make the instruments. Having fulfilled all possible conditions, he was fully paid in 1767. His time-keepers are still preserved, in charge of the astronomers royal, in Greenwich Observatory.

Egyptian Identifications.—Dr. Edouard Naville, to whom the world owes the recovery of the cities of Bubastis and Pithom, in Egypt, gave a summary of the results of his work in excavating other cities of Egypt before a meeting of the Victoria Institute in June. His explanations related principally to places connected with the Exodus. He had found that Succoth, whither the children of Israel journeyed from Rameses, was not a city, as some had supposed, but a district. An inscription discovered at Pithom left it no longer doubtful that that place was the ancient Heroopolis, whence, according to Strabo, Pliny, and other authors, merchant ships sailed to the Arabian Gulf. This fact coincided with the results of modern scientific surveys, which showed that there had been a gradual rising of the land, and that the Red Sea once extended up to the walls of Pithom. The identification of Baal Zephon had been aided by some papyri, which proved that it was not a village or a city, but an ancient shrine of Baal and a noted place of pilgrimage. Other places were Migdol and Pi Hahiroth, in the identification of which the author had again been aided by a papyrus, and it seemed probable that the Serapeum was the Egyptian Maktal or Migdol. It was greatly to be regretted that a bilingual tablet discovered there a few years ago had been destroyed before being deciphered.

Forest Reproduction in New England.—The question whether our forests are disappearing is answered in one way by Mr. I. H. Hoskins, of Newport, Vt., who says, in Garden and Forest: "In northern New England they certainly are not. The farmer has a constant struggle against the persistent spread of seedling trees over his cleared land; and if man should abandon this region I think in a hundred years it would hardly be possible for a visitor to realize that it had ever been inhabited by civilized man. It is this constant back-pressure of the forest upon intruding settlements that prevents the average farmer from taking an interest in forestry. He has to fight for his life against the forest, and the idea that the forests are likely to be extirpated seems to him quite absurd. One of the largest and finest sugar orchards in this town was seventy years ago a wheat-field." While this is true of some regions, Garden and Forest remarks, there are other vast areas that will never reforest themselves; and the new forests are of inferior quality to the old ones which they succeed.

Astronomy and Numismatics.—A curious suggestion is made by Dr. A. Vercoutre, of a way in which astronomical knowledge may be made of service to numismatical science. Stars and members of the solar system often figure on antique medals, notably on coins of the Roman republic, and they sometimes appear as heraldic allusions to the magistrate by whom the coin was struck. Thus, on a coin of L. Lucretius Trio, 74 B. C., the seven stars in Ursa Major —called by the Romans Septem Triones— appear in evident phonetic allusion to the name, Trio, of the magistrate. On a coin struck in B. C. 43, Dr. Vercoutre noticed five stars, one of which was much larger and more brilliant than the others. As the constellation Taurus contains the only group of five stars, with one much the brightest recognized by the ancients, the

author attributed the coin to P. Clodius Turrinus, who used the name Taurus or Taurinus as a phonetic equivalent of his own. A coin struck by Marcus Aquillius, B.C. 84, has figured on it the first four stars of the constellation Aquila. They are shown in nearly the same relative positions they now occupy, and therefore contain the earliest known representation of a part of the celestial vault.

Native Jade in Europe.—From the occurrence of articles of jade in ancient graves in Europe and America, while the only known quarries of that mineral were in Asia, archæologists have concluded that all the materials used by the prehistoric artisans must have had an Oriental origin. Prof. F. W. Rutley has shown that this conclusion is no longer necessary. Within the last few years Herr Traube, of Breslau, has discovered nephrite, or true jade, in places near Jordansmühl and near Reichenstein, in Silesia. Pebbles of nephrite have also been recently recorded by Dr. Berwerth from the valleys of two rivers in Styria. A pebble believed to be of jadeite has been found by M. Damour at Ouchy, on the Lake of Geneva, and the same mineral has been recorded from Monte Viso, in Piedmont. Dr. G. M. Dawson has recorded the discovery of small bowlders of jade, partially worked, in the lower part of the Fraser River Valley, and Lieutenant Stoney has obtained the mineral in place at the Jade Mountains, in Alaska, [illegible] miles above the mouth of the river Kowak. The present aspect of the jade question is, therefore, different from that which it presented when the late Prof. Fischer and others favored the view that the jade implements of America and Europe were of exotic origin. It seems now probable that in both continents the material of the implements is indigenous.

Causes of Baldness. — The probable causes of baldness are summed up by Dr. Joseph Tyson as, in their order, insufficient exposure of the hair; influence of heredity; excessive mental work and great anxiety; venereal and alcoholic excesses; and constant washing and want of pomade. Preventive treatment is advised. Children should, as much as possible, do without caps, and their hats, when worn, should be of the lightest description. A shaded hat may be necessary during the hot season, for the prevention of sunstroke. Head-coverings should not be worn indoors, in trains, or in closed carriages. Straw hats are preferable in summer and in still weather; in winter, hats made of light felt, well ventilated and unlined. The ordinary tall hat, or stove-pipe, and the thick, heavy, unventilated top hat, can not be too strongly condemned. The second cause does not admit of practical treatment, while the course to be pursued with the third and fourth causes is obviously one of avoidance. Too constant washing of the hair is unnecessary as well as harmful. Once a week is enough for cleanliness and for maintaining the strength of the hair. Excessive brushing, especially with hard brushes, should be avoided. The author advises the application of some form of simple grease or oil, after the hair has been washed; and, when the head hair is becoming rapidly thinned, some stimulating material, such as ammonia and cantharides, applied to the oil, will increase its good effects.

The Mesopotamian Desert.—The Mesopotamian Desert, according to Dr. B. Moritz, comprises two thirds of the southern part of the country, forming an unbroken plain with little or no vegetation, except in the depressions where rain-water collects or the inundations penetrate. Piles of ruins, or hills—which the inhabitants designate by a name signifying "signs"—rise from these perfectly level plains from the height of a few yards to a hundred feet, and are sometimes several miles in diameter. Some of the walls and buildings still tower aloft, and, in more recent ruins, lines of streets can yet be traced; the dams of ancient canals are still visible, and are sometimes fifty feet high. The atmosphere is murky, so that the highest hills are obscured at a distance of a few miles. Dust-storms, for which abundant material is furnished by the old crumbled walls of brick, fill the air at times so that the sun is obscured; and in time they have changed the appearance of the country by blocking up the ancient canals and forming long, parallel lines.

They now threaten to cover up the few existing fields on the Tigris. While extensive tracts in these regions have been lost to cultivation from the lack of water, another part is suffering from its superabundance, and the land is swamp at the normal level of the streams. Such is now what was once the most populous region of the earth.

Tests of Woods.—A system of tests of woods was described by Prof. Fernow at the meeting of the American Association, which have been undertaken at the Department of Agriculture for the determination of the relation of technical and physical qualities to each other and to conditions of growth. The method includes the selection of test-material from as many essentially different soil and climatic conditions as the species may occupy; the examination of the structure and physical condition of the material down to the minutest detail; the usual testing with special care; and the compilation and comparative discussion of the results of the tests in connection with the physical examination and the known conditions of growth. Besides more reliable data than have been hitherto obtained of the qualities of our principal timbers, the investigation promises to furnish us with a knowledge of the conditions under which desirable qualities can be produced by the forest-grower.

Phosphorus in Plants and Animals.—In a paper presented to the American Association meeting in 1890, Mr. Walter Maxwell showed that a vegetable organism, during the initial stages of growth and under the action of the ferments operating in germination, possesses the power of taking the phosphorus present in seeds or in soils as mineral phosphates, separating the phosphorus from the inorganic combination, and causing it to appear in the young plantlet in an organic form as a lecithine. In a second part of his paper, which was read at the association meeting of 1891, the author showed that the lecithine bodies present in the animal kingdom revert to the mineral form under the action of the ferments present in the animal organism. The phosphorus contained in a hen's egg, with which the investigations were conducted—both in the forms of mineral phosphates and of organic phosphorus compounds as lecithines—was first determined. Next, eggs were incubated, and the products of incubation were studied. It was found that the phosphorus contained in the natural egg as a lecithine reappeared in the incubation product as calcium phosphate, forming the bone of the chicken. It thus appears from the investigations that the lecithine bodies are a medium through which phosphorus conducts its circulation between the mineral, vegetable, and animal kingdoms—passing from the mineral, through the vegetable, into the animal kingdom, where it reappears as a mineral compound.

Carpet-weaving in Persia.—Few ancient carpets are to be found in Persia now, the stock having been gathered up by European travelers, merchants, and curio hunters. It may seem almost incredible to many people that among the ancient carpets so many are still in good condition and comparatively little worn. The secret of this is, according to M. G. de Vries, that not only has great care been bestowed on the weaving of the carpets and on the quality of wool used, but because of the custom prevailing in the houses of Eastern people. While we enter our own and other people's rooms with the same boots with which we walk through the muddy streets, a Persian never enters any room without leaving his boots or shoes at the door. The most important present manufacture of carpets is carried on at Sultanabad. The weaving is done exclusively by women. The only share the men take in the work is, that to them the merchants give out the designs, the colors, and the money required for the weaving. The loom is an inexpensive and simple structure, consisting of four wooden poles, which generally occupy the whole length of the weaving-room. When weaving is going on regularly, three or four women work at a carpet of fairly large size, the weaver's wife being, as a rule, the principal weaver, and at the same time superintending the work of her daughters or hired women. The rule is, that, at each end of the board on which the women are seated, there shall be one female overseer. For carpets of very large size, in the weaving of which seven or eight women are employed, there is also an overseer in the middle. At the age of seven years girls begin to assist in the

weaving; previous to that age they spend a year or so on the board watching the other women so that they may get accustomed to the work. If a young woman who has been brought up to the loom gets married, the first thing she does is to try and obtain an order for a carpet, so that the weaving of carpets passes from one generation to another. Every stitch in the carpet is made separately, and it is afterward clipped with the scissors and beaten down. In a good carpet there are about ten thousand stitches to every square foot. The clipping must be done every time with equal care, otherwise when the carpet is finished the pile will be short in some places and longer in others. Upon the beating down depends the closeness of the texture; the more a weaver beats her stitches down, the finer, of course, the carpet is. She knows how many stitches she has to weave to every quarter of a Persian yard; but she generally makes less, in order to save wool, time, and trouble. The designs are the individual property of the weavers, and are protected by law. The shades of color are a matter of importance, and attention is paid to having them in harmony with the varying tastes of the European markets. Besides woolen carpets, rugs are exported, woven entirely of silk. The weaving of such rugs is done in the same way as the weaving of carpets, but the labor is far greater in proportion, as they are always of a very fine make. Such rugs can be used as table or sofa covers, portières, etc., but, as they are made of pure silk, they are very costly.

Holy Stones of the East and the West.—A curious paper was read by Mr. Charles G. Leland at the International Congress of Orientalists concerning the salagrama stone of India and the salagrana of the Toscana Romana, as a curious link connecting the East and West. The Indian salagrama is a kind of ammonite, the size of an orange, and having a hole in it. According to the legend, Vishnu the Preserver, when pursued by the Destroyer, was changed by Maya into the stone, through the hole of which the Destroyer as a worm wound his way. The Italian salagrana is a stalagmite, which is believed by the people, on account of its resemblance to the little mounds thrown up by earthworms, to be such a mound petrified. They carry it in a red bag, along with certain magical herbs, and pronounce over it an incantation to the effect that the irregularities and cavities in it have the property of bewildering the evil eye and depriving it of its power. The author was informed by believers in such things that anything like grains, irregular and confused surfaces, interlaced serpents, or intricate works, blunted the evil eye. Interlaced cords are sold in Florence as charms. Even the convolvulus is grown in gardens against the evil eye. In the Norse mythology, Odin as a worm bored his head through a stone in order to get at "the mead of poetry." Hence all stones with holes in them are known as Odin stones, also as "holy stones," and are much used at the North as amulets. Hung at the head of the bed, they are supposed to drive away nightmare. Possibly there is a connection with the salagrana here. So interlacings in decoration may be originally designed to avert the evil eye and bad luck. A recent traveler in Persia was told that the patterns on carpets in that country were made intricate so that the evil eye might be bewildered. In the salagrana of Italy the number of grains or protuberances must be counted one by one before the witch can do evil. In the Arabian Nights the ghoul Amina must eat her rice grain by grain; and in South Carolina the negroes protect a person who is bedridden or nightmared by strewing rice round his bed, which the witch, when she comes, must count grain by grain before she can touch her victim.

Two Ancient Races.—Describing, in the International Oriental Congress, his excavation of the pyramid of Medum—the tomb of King Senefru, of the third Egyptian dynasty, and the oldest known building in the world—Mr. H. Flinders Petrie spoke of the entire skeletons which had been obtained of men of that remote period (some 4000 years B. C.) as providing an anatomical study of importance for ethnology. The peculiar mode of interment of most of these persons shows that a religious difference then existed. The bodies of the highest class or race were interred, extended at full length, with vases of pottery or stone, and head-rests; while the greater number of the bodies were interred

contracted, with the knees drawn up to the breast, even when the chamber was long enough to hold them extended; and they were not mummified No pottery was interred with them, except one or two rough vases in one tomb. This treatment was not due to neglect, for the deceased were always placed with great care and regularity, with the head to the north, the face to the east, and the body lying on the left side. Such essential differences in the mode of interment, and the provision for the deceased, point to a difference of race. The contracted interment may have pertained to one of the prehistoric races, and the extended interment with provision of vases, etc., to the dynastic race. The skeletons were well preserved, but tender and friable; the bones lay in their places, and the linen cloth wrapped around the body was intact. Rheumatic disease and other maladies of the bones were already well known at that period.

Non-drinking Sheep and Cows.—The facility with which animals can adapt themselves to altered conditions of existence is illustrated by Dr. A. J. Crespi in an article in the Gentleman's Magazine on Curiosities of Eating and Drinking. He quotes from Miss Betham Edwards's account of her excursions in the barren, stony, wilderness-like region of the Causses of France the description of some of the interesting facts which it affords to evolutionists. "The aridity, the absolutely waterless condition of the Larzac has evolved a race of non-drinking animals. The sheep, browzing the fragrant herbs of these plateaus, have altogether unlearned the habit of drinking, whilst the cows drink very little. The much-esteemed Roquefort cheese is made from ewe's milk—that of the non-drinking ewes of the Larzac. Is the peculiar flavor of the cheese due to this non-drinking habit?"

NOTES.

Mr. H. A. Hazen maintained in the American Association that the opinion that tornadoes whirl is a mistaken one. Of the two ways of learning the shape of tornadoes, that of observing them directly is burdened with difficulties, and is neither satisfactory nor accurate; while the study of them by observation of their *débris* is easy, and will lead to correct conclusions. Reports of such observations of between two hundred and three hundred tornadoes have been received at the Weather Bureau during the past two years, and the evidence from them is overwhelmingly favor of the view that there is no whirl.

A description of the methods pursued in the Geological Survey of the United States was given, with graphic illustrations, by Major Powell to the International Geological Congress. The speaker explained that, inasmuch as the Survey is a national institution, supported by taxes paid by the public, the results of its work are made intelligible to the people, and are not prepared so as to be understood only by men of science.

The Committee on Forestry in the American Association reported that, under a recent law authorizing the President to withdraw from sale or other disposal such public timber-lands as he may deem fit, the boundaries of Yellowstone Park had been enlarged. A necessary enlargement of the Yosemite Valley reservation was anticipated, and a number of other reservations in Minnesota, Montana, Idaho, Colorado, and California, comprising several million acres, would be asked for in a memorial prepared by the American Forestry Association.

The next meeting of the International Geological Congress will be held in Berne, Switzerland, in 1894. The Geological Survey of Russia, supported by the Czar, invites the Congress to hold its meeting in 1897 in St. Petersburg.

According to a paper by G. L. Spencer and E. E. Ewell, in the American Association, wheat flour and bran mixed with molasses seem to be the favorite materials for the manufacture of imitation coffees. It is hardly probable that the manufacturer selects a good quality of flour, for a bad or damaged article would be cheaper. Refuse crackers and other waste of bakeries probably supply a portion of the material employed. A factory recently seized in France employed a mixture containing 500 grammes of ferrous sulphate, 15 kilogrammes of chiccory, and 35 kilogrammes of flour. With the exception of such mixtures as this, imitation coffee is not detrimental to health, but especially affects the purse of the purchaser.

A curious feature of old-time life is recalled in Mr. Freshfield's paper before the British Society of Antiquaries on the wrought-iron sword-stands in the churches of the city of London. These sword-stands, of which two leading and various subordinate types were described, appear to have come into fashion in the reign of Queen Elizabeth; but only one or two of the older ones survived the great fire, and most of those now existing are of the eighteenth century.

Prof. Putnam announced, at the last meeting of the American Association, that the Government of Honduras had granted to the museum at Cambridge, Mass., the exclusive right to explore the scientific resources of the country for a period of ten years.

A paper by Prof. A. N. Krassnof, read at the meeting of the Geological Society of America, traced the resemblance of the black soils of the Russian steppes and the prairies of America to their similar origin in the layers of successive annual crops of plants.

As described by Charles B. Thwing, the results obtained with Lippman's process for color photography, though not conclusive at all points, seem to indicate that the mixed colors may be reproduced with some fair degree of accuracy. Modifications are introduced by a change of thickness of the film between exposure and final drying, and by a shortening of the distance between maxima caused by the rays striking the reflector at an angle other than the normal. A second result is that an exposure long enough to give a clear image of the red is certain to obliterate the blue by over-exposure; and a third, that an over-exposure may completely reverse the colors, causing the original colors to appear on the reverse and the complementary on the film side of the plate.

Prof. Jastrow describes some curious tests which he made with a young man who had been born without the sense of smell, for the purpose of determining what things are tasted when we eat and what are smelled. It appears that many things which we relish are not tasted, but only smelled.

A paper by Mr. John Watson, of Manchester, England, asserts that the redevelopment of lost limbs is not unusual among insects. He has had three specimens in which limbs have been redeveloped, and one case of complete cicatrization. "Redevelopment," he says, "can take place either in the larval or the pupal stage of an insect's metamorphosis."

OBITUARY NOTES.

Mr. William Ferrell, an American meteorologist of world-wide reputation, died in Kansas City, Mo., September 18th, about seventy-four years old. He was graduated from Bethany College in 1844, became assistant in the American Ephemeries and Nautical Almanac in 1857, and held the place for ten years; was then appointed on the staff of the United States Coast Survey, when he invented the machine for predicting the maxima and minima of tides; was made assistant, with the rank of professor, in the Signal-Service Bureau in 1882; and retired from that position in 1886 to make his home in Kansas City. He published many works, large and small, of researches on the tides or pertaining to meteorological problems; a volume on Recent Advances in Meteorology (1883); a Popular Treatise on the Winds in 1889; and contributions to scientific journals and societies on such topics as thermal radiation, cyclones, tornadoes, and related subjects of terrestrial physics. His earliest scientific writings were contributed in 1856 to the Nashville Journal of Medicine and Surgery. He was a member of the National Academy of Sciences, and an honorary member of the meteorological societies of England, Germany, and Austria.

Prof. Martin Duncan, F. R. S., whose death has been recently announced, was a special student of fossil corals and echinoderms, and published some valuable memoirs upon them. He was for a long time Professor of Geology in King's College, and there published an account of the Madreporia collected during the expedition of the Porcupine, a description of deep-sea and littoral corals from the Atlantic and Indian Oceans, and a revision of the Echnoidea. He also published many popular articles, including Corals and their Polyps, Studies among Amœbæ, Notes on the Ophiurans, or the Sand and Brittle Stars, and a book on the Sea-shore in the Natural History Rambles series of the Society for Promoting Christian Knowledge.

The death, by apoplexy, is announced of Dr. L. Just, Professor of Botany at the Polytechnicum, Carlsruhe, Director of the Botanic Garden there, and editor of the Botanischer Jahresbericht.

Dr. Francis Brunnow, an astronomer equally distinguished in America and Europe, has recently died in Heidelberg, Germany, in his sixty-seventh year. He was associated with Encke in Berlin, and there had a part in the discovery of Neptune. He investigated the motion of De Vico's comet of short period, which, however, has never been seen since. He also, at Berlin and Ann Arbor, Mich., where he became director of the observatory in 1854, calculated the theory of some of the minor planets. He published at Ann Arbor a periodical, Astronomical Notices, which is now very rare. His Lehrbuch der spherischen Astronomie has passed through several editions. He was appointed Professor of Astronomy in the University of Dublin and Director of the Dunsink Observatory in 1865. Retiring from those positions in 1874, he lived the rest of his life in private.

Dr. Barclay, who recently died in Simla, India, was a specialist in cryptogamic botany, and had acquired an extended reputation by his researches in the diseases of Indian plants He was engaged at the time of his death with the commission for the investigation of leprosy.

ELIAS LOOMIS.

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RECENT ADVANCES IN THE POTTERY INDUSTRY.

By EDWIN ATLEE BARBER.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XI.

THE revelations of the Centennial Exhibition set our potters to thinking and stimulated them to greater competition. Never before was such an impetus given to any industry. The best productions of all nations were sent here and exhibited beside our own modest manufactures, and it was only too apparent that America had been left behind in the race. Up to that time there had been a few sporadic instances of attempts at originality, but comparatively little had been accomplished of a really artistic nature. The existence of a true ceramic art in this country may be said to have commenced with the fair of 1876, because greater progress has been made within the fifteen years which have elapsed since that important event than during the two centuries which preceded it. Let us see what rapid strides have been made in this period.

At the United States Pottery in Bennington, Vt., was a young man, Mr. L. W. Clark, son of the superintendent, Mr. Decius W. Clark, who, on the closing of that factory, accompanied his father to Peoria, Ill., and remained with the firm of Fenton & Clark for about two years, when he left to enter the army. In 1875 he went to Boston, and, in partnership with Mr. Thomas Gray, assumed control of the New England Pottery. This establishment was founded in 1854 by Mr. Frederick Meagher, who made Rockingham and yellow ware. It was afterward taken by Mr. William H. Horner, from whom the plant was purchased by the present proprietors, who now produce the usual lines of useful services in cream-colored and white granite ware. For the past five years

they have been making a decorated product in colored bodies, to which they have given the name "Rieti" ware. This is a semi-porcelain, finished and decorated chiefly after the Doulton, Adderley, and Worcester methods. They also make true hard porcelain of an admirable quality, and their goods are characterized by an artistic style of decoration and excellence of glaze, their mazarine blue and "old ivory" finish being especially praiseworthy. The decorating branches are under the direct supervision of Mr. J. W. Phillips, who originates and engraves many of the best designs used in their printing processes. Most of their shapes are utilitarian rather than ornamental, but they have succeeded in imparting to these a grace of outline and delicacy of coloring which render them objects of great beauty. Their chocolate-jugs, *jardinières*, and cuspidors compare very favorably with the imported wares, after which they are to some extent patterned. Of the few purely decorative forms which they have attempted, a semi-porcelain vase, twenty inches in height, made in 1889, is particularly meritorious. This is artistically painted in natural colors on raised paste, the top and base being in solid, dead gold. Mr. Bands, of the Royal Worcester Works, England, was the artist.

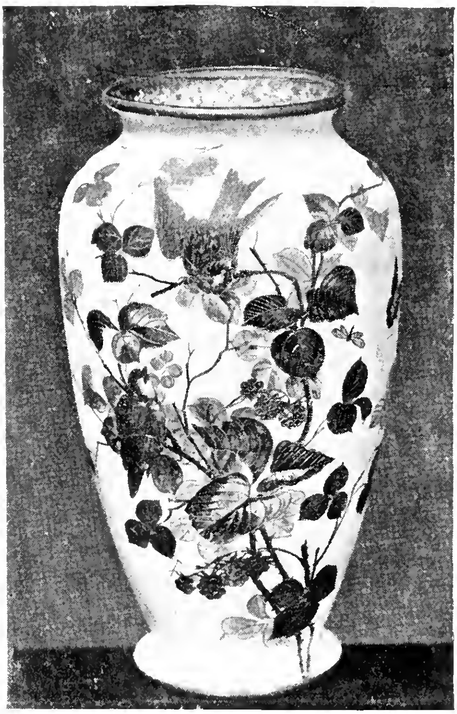

Fig. 18.—Semi-porcelain Vase.
New England Pottery Company, 1889.

The Ott and Brewer Company, of Trenton, N. J., now operates the factory which was built by Messrs. Bloor, Ott & Booth, in 1863. Mr. J. Hart Brewer, president of the company, entered the firm in 1865, and, being an artist himself of considerable ability, soon made his influence felt in the improvement of methods and elevation of standards. Until 1876 the chief products of this factory consisted of white granite and cream-colored ware. At the Centennial Exhibition the company made a display of a series of artistic Parians which had been designed mainly by Mr. Isaac Broome, an American artist of remarkable versatility and great promise. Of these special pieces,

probably the most noteworthy are a bust of Cleopatra and a vase with modeled figures of base-ball players.

The first attempts in the manufacture of "Belleek" egg-shell china were made by Mr. Brewer in 1882, in conjunction with Mr. William Bromley, Jr., but these early trials were not entirely satisfactory. Encouraged by partial success, however, Mr. Brewer induced Bromley to send for his father, William Bromley, and his brother, John Bromley, who, with two or three other hands, came over in the following year from the Belleek factory in Ireland. Mr. William H. Goss, of Stoke-on-Trent, invented this body some thirty years ago, at which time the elder Bromley was acting as his manager. Messrs. David McBirney and Robert Williams Armstrong were then attempting to make first-class ceramic goods at their recently established manufactory in the village of Belleek, county of Fermanagh, Ireland. Mr. Armstrong induced Bromley to take a number of Mr. Goss's best workmen to Ireland and introduce the egg-shell porcelain there. The ware produced at that factory has since become world-famous, being characterized by extreme lightness of body and a beautiful, lustrous glaze.

Fig. 19.—Belleek Vase. Ott and Brewer Company.

The ware now manufactured by the Ott and Brewer Company is made entirely from American materials, and is a vast improvement over the body and glaze first introduced by the Bromleys eight years ago. In the rich iridescence of the nacreous glaze it is fully equal to the original Belleek; in delicacy of coloring and lightness of weight it is even superior. A dozen cups and saucers, making twenty-four distinct pieces of the ordinary size, almost as thin as paper, weigh just one pound avoirdupois, or an average of only two thirds of an ounce each. A large variety of forms of this porcelain are produced, in both ornamental and useful designs. The larger vases are usually simple in outline and of the same comparative lightness as those of smaller size. They often possess pierced necks, feet, and handles, and are elegantly decorated in enamels, gold relief, and chasing.

A triumph of the potter's skill is a Belleek ostrich-egg bonbon-box, in two segments, which is exquisitely perforated or honey-combed over its entire surface. We can not here reproduce more than one or two examples of these beautiful fabrics. One is a

large vase of the "Bourne" pattern, decorated in raised gold and colors. The shape is graceful and the decoration is exceedingly artistic (Fig. 19).

In addition to art porcelains, this factory produces a great quantity of granite ware and opaque china, in dinner, tea, and toilet sets, which are both print-decorated and hand-painted. A *jardinière* of white granite, which we here figure, is a refined example of artistic decoration in quiet tones.

One of the most extensive establishments in the Eastern States is that of the Willets Manufacturing Company of Trenton, N. J.

Fig. 20.—White Granite Jardinière. Ott and Brewer Company.

The present proprietors, Messrs. Joseph, Daniel, and Edmund R. Willets, three brothers, succeeded to the business in 1879. The factory was erected in 1853 by William Young and Sons, who at first made Rockingham and common ware. At the Centennial Exhibition William Young's Sons made a display of crockery and porcelain hardware trimmings, at which time the plant included only four kilns. The business has since grown to such an extent, under the present management, that there are now thirteen large ware kilns besides those used for decorating. The products from these works include sanitary earthenware, plumbers' specialties, white and decorated pottery, opaque china, white granite, and art porcelain. A specialty in dinner and toilet services is underglaze decoration on white bodies.

After the Ott and Brewer Company had perfected the body and glaze of their Belleek ware and got it well under way, William Bromley, Sr., went with the Willets Manufacturing Company and instructed them in the process. The manufacture of

white egg-shell ware, to which they are constantly adding new designs, is another specialty of these works, and the company is now competing successfully with the Dresden and other foreign factories in supplying white art porcelain to decorators. In form their pieces are graceful and artistic, one of which is represented in Fig. 22.

They also employ a number of competent artists to decorate their art goods, many of which are reproductions of the characteristic shell and coral forms of the Irish works. Fig. 23 represents a large Belleek vase with open-work handles and chrysanthemum decoration in delicate tints on an ivory, gold-stippled ground.

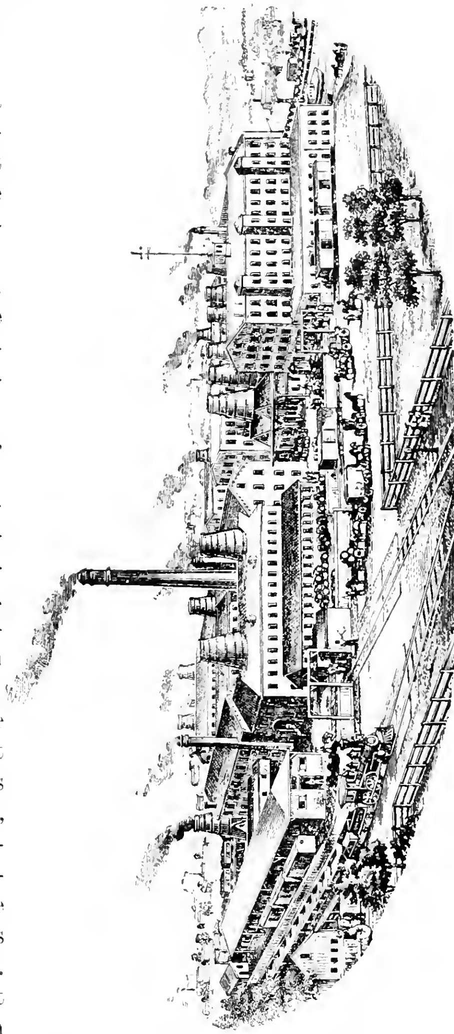

Fig. 21.—Works of the Willets Manufacturing Company, Trenton, N. J.

The Ceramic Art Company, of which Mr. Jonathan Coxon, Sr., is president and Mr. Walter S. Lenox secretary and treasurer, was established in Trenton in 1889. The first named gentleman became superintendent at the Ott and Brewer Company's works after Bromley left, and the latter was formerly in charge of their decorating department. Here they learned the processes of manufacturing Belleek. Although they have at present but one ware kiln and two decorating kilns, they are rapidly making a name by their constantly increasing patterns, many of which are exquisitely conceived and show the touch of a thorough artist. They have procured the best designers and painters that can be found and employ both the overglaze and underglaze processes in decorating. Their egg-shell ware is also furnished in the white to decorators. Fig. 24 shows one of these undecorated pieces, a graceful lily-shaped cup and saucer. In addition to vases and table pieces, they

make many fancy patterns, such as thimbles, inkstands, parasol-handles, menu slabs, and candelabra.

The Phœnixville (Pa.) Pottery, Kaolin, and Fire-brick Company was organized in 1867, and a few years later was succeeded by Messrs. Schreiber & Co., who made yellow and Rockingham ware, and terra-cotta ornaments and wall-pieces. Heads of hounds and stags in several sizes, and large boars' heads, were made extensively here, and twenty years ago were in demand for decorating the interiors of public-houses. Many of these may still be seen in country taverns. These were considered works of considerable artistic merit when first produced. The antlers and horns of stags and antelopes were made separately and afterward inserted. Messrs. Beerbower & Griffen took the pottery in 1877 and commenced the manufacture of white granite. In 1879 the firm name was changed to Griffen, Smith & Co., and in the following year the manufacture of "Etruscan" majolica was added. From 1880 to 1890 the factory produced a good grade of white and decorated china, mostly in table services and toilet sets. Through their majolica and "stucco" productions, however, the firm became more widely known, and within the past few years they have made many decorative pieces in shell and dolphin patterns, after the Irish Belleek forms. Since the fire, which destroyed a large portion of the works recently, the manufacture of majolica has been discontinued. Mr. Smith withdrew from the firm in 1889 and erected levigating mills at Toughkenamon, Pa., near which place are large beds of kaolin. The firm style was then changed to Griffen, Love & Co.

Fig. 22.—Shell and Cupid Pitcher—Belleek. Willets Manufacturing Company.

As early as 1882 experiments were commenced in the manu-

facture of hard porcelain, and a series of sample pieces were made for the New Orleans Exhibition. The quality and designs of these trial pieces were creditable, and the experiment has shown that this factory is capable of producing true porcelain of a high order. One of the New Orleans pieces, a pitcher of thin semi-transparent body, was also made in white earthenware, glazed and gilded, the latter of which is reproduced in Fig. 25. It is in the shape of a canteen, the mouth representing the head of a Continental soldier. The raised designs are flesh-colored, on a solid gold ground. The three-cornered hat is black. Mr. Scott Callowhill, an English artist of ability, was employed for a while in modeling and painting, but recently left, to accept a position with the Providential Tile Works of Trenton.

At the beginning of the present year a change was made in the proprietorship, and a new company has been incorporated, under the title of the Griffen China Company, which will hereafter make a specialty of fine translucent French china, in plain white table services. The company will also, at an early day, manufacture fancy tiles, under the direction of Mr. A. D. Vitan, a practical French potter, formerly at Greenpoint, Long Island. This gentleman has just perfected an improved machine for manufacturing art tiles, and another for making plates.

Fig. 23.—Large Vase—Chrysanthemum Decoration. Willets Manufacturing Company.

The Borroughs and Mountford Company commenced business in Trenton in 1879, in what was formerly the Eagle Pottery. Their specialties are vitrified, thin, and hotel china, and underglaze printing on pottery and porcelain. The mechanical application of decorations is the distinguishing characteristic of one line of their art potteries, which, while closely imitating the more expensive methods of hand-painting, enables them to produce highly artistic effects at a greatly re-

duced cost. The bold ornamentation of their *jardinières*, umbrella-jars, punch-bowls, and vases, after the Doulton, Royal Worcester, and Adderley methods, bears a striking individuality of its own. Probably their most beautiful pieces are those on which raised gold designs are applied by hand to an exquisite mazarine blue. White tiles of the finest quality, with underglaze blue printed devices, as well as embossed and art tiles, are also made to some extent.

Fig. 24.—Egg-shell Porcelain—The "Engagement" Cup and Saucer. Ceramic Art Company.

The Greenwood Pottery Company, incorporated in Trenton in 1868, make a specialty of the manufacture of vitrified and translucent china for hotel, steamship, and railway uses. This pottery was established in 1861, under the style of Stephens, Tams & Co. They are also making, at the present time, thin china table ware for domestic purposes, porcelain hardware trimmings, and electrical, telegraph, and telephone insulating supplies. Some years ago they added an art department to their extensive establishment, and their decorated productions are characterized by elegance of form, being decorated usually in the Royal Worcester style, with ivory finish and raised gold, silver, and bronze effects. The plant of the company consists of seventeen large kilns, with an annual producing capacity of over half a million dollars.

Fig. 25.—White-ware Pitcher. Phœnixville, Pa.

Among the other important Trenton establishments is that of Messrs. Oliphant & Co., which turns out large quantities of plumbers' sanitary appliances, druggists' and jewelers' supplies. About 1886 the late Mr. Thomas Connolly, a partner in the concern, commenced experimenting in Belleek wares, having been at one time connected with the Irish works. He succeeded in producing some exquisitely thin trial pieces, and demonstrated the fact that these works could manufacture egg-shell ware of the highest grade. The few pieces which were produced, consisting

of small ewers, cups and saucers, were fired in the large kilns with the sanitary ware. For some unknown reason, however, this

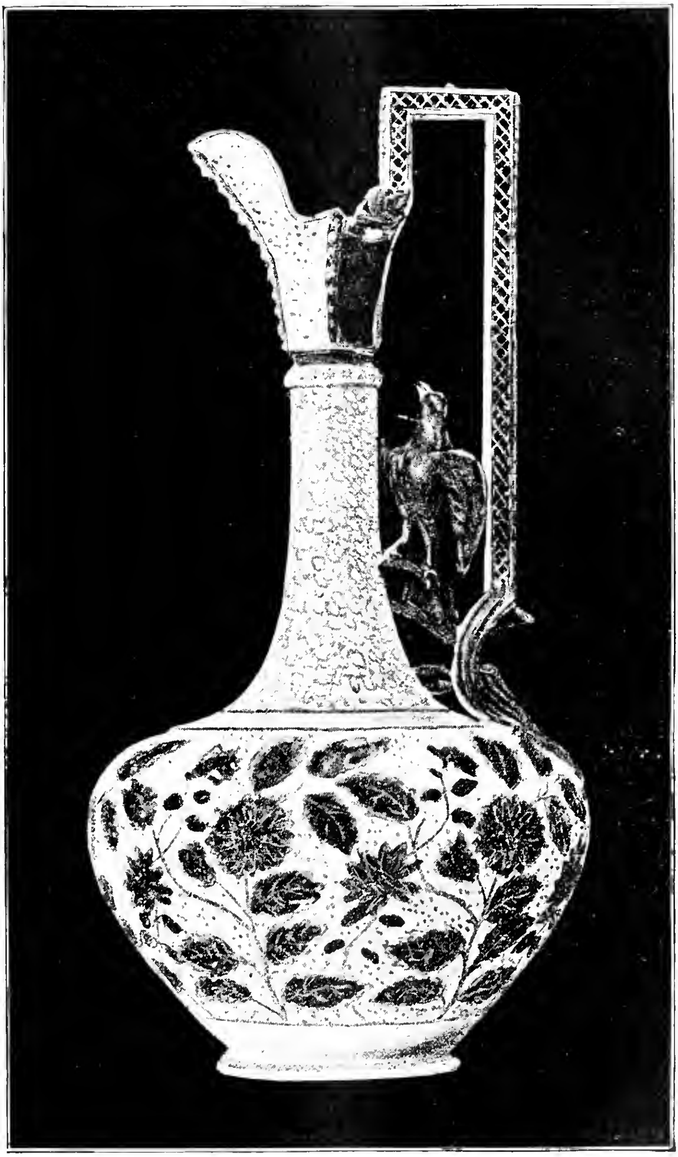

FIG. 26.—EWER VASE. Faience Manufacturing Company.

branch of the business was never developed beyond the experimental stage.

The Knowles, Taylor and Knowles Company, of East Liverpool, Ohio, have the largest works in America, their plant covering ten

acres and including thirty-five ware and decorating kilns. The business was started in 1854 by Mr. Isaac W. Knowles and Mr. Isaac A. Harvey, who, with a single kiln, made yellow ware and, later, Rockingham. In 1870 Mr. Knowles, who had purchased the interest of his former partner, was joined by Messrs. John N. Taylor and Homer S. Knowles, and in 1872 they commenced the manufacture of iron-stone china and white granite ware. The business of the company has had a phenomenal growth, and at the present time they employ about seven hundred hands in the production of extensive lines of white granite and vitreous hotel china, which they supply to the trade.

The Faience Manufacturing Company, of Greenpoint, Long Island, produces white ware artistically decorated and, we believe, a limited quantity of porcelain. The pieces are of ornamental rather than of useful shapes. The engraving (Fig. 26) represents a ewer vase from this factory with open-work handle and molded figure of bird. It is unfortunate that the secrets of this factory should be guarded so jealously as to deprive us of all knowledge concerning the processes employed and the qualities of the wares produced. Repeated inquiries have failed to elicit any reply.

To Mr. Thomas C. Smith, of Greenpoint, Long Island, belongs the honor of being the first American manufacturer who has been successful in placing upon the market a true hard porcelain as a commercial article. His experiments, which extended over a number of years, first commenced to bear fruit about 1865, when he perfected a plain white ware, and a year afterward he commenced to decorate his goods. The Union Porcelain Works, of which Messrs. Thomas C. Smith and C. H. L. Smith are the proprietors, have produced many decorative pieces in addition to their staple productions of true porcelain table ware.

This porcelain is composed in body of clay, quartz, and feldspar. It is fired in biscuit at a low temperature, in the second story of the porcelain kiln, using for its baking the surplus heat passing away after having done its greater work in the first story or gloss-kiln where the glazing is done. At this first burning the ware receives only sufficient fire to make it properly fasten together in form. It is quite fragile, easily broken with the fingers, and porous, not having yet had sufficient heat to commence vitrification. In this condition it is what is termed porcelain biscuit, and is ready for the glaze-tub. The glaze of porcelain is composed of the same material as the body, and so compounded that those elements which are soonest fluxed by the influence of the heat are in greater proportion than they are contained in the body. The porous, low-fired biscuit is dipped into a liquid puddle of glaze. Upon being withdrawn its porosity quickly absorbs the excess of water, leaving a dry coating of the glaze compound,

which was held by the water in suspension, upon the surface of the piece. This piece of porous biscuit covered with glaze is now cleaned of glaze upon its foot, or that part upon which it rests, to prevent its sticking or burning fast to the clay "sagger" or firing case; otherwise the glaze on the bearing parts would, at the time of flowing, form a cement, fastening the piece and the sagger together. The pieces are placed separately in the saggers. The heat in firing hard porcelain is carried to such a high degree that the ware touches the point of pliability, almost the melting-point. At this point of heat the body is vitrified; at the same time the glaze, from its slightly softer composition, is melted into the body of the ware, producing a hard, vitreous, and homogeneous material properly known as true, hard porcelain. This is the process used at Sèvres, Meissen, Berlin, and elsewhere.

Fig. 27.—Bust of Edwin Forrest as William Tell.
Union Porcelain Works.

The earthenware method is just the reverse of this. The body is composed of much the same materials as a porcelain body, but differently compounded, and it is baked in biscuit at the first firing at a greater heat than is required for porcelain biscuit, and receives during that first burning the greatest heat to which it is subjected in the entire process of manufacture. The glaze is composed partly of the same materials as compose the body, with the addition of oxide of lead and boracic acid, which latter, being soft, fluxes in the fire, enabling the glaze to flow at a low heat. It is fired the second time in the gloss-kiln at a lower temperature than it has previously been fired in biscuit. This results in flowing the soft glaze over the surface of the ware, making substantially a lead-glass film or coating upon the surface of different compounds and materials, not homogeneous, not a part of the

ware by being fused into the body as in porcelain. The body and glaze being thus in constant antagonism to each other, produce sooner or later what is technically called "crazing" or cracking of the enamel, for the reason that the body is one thing, produced

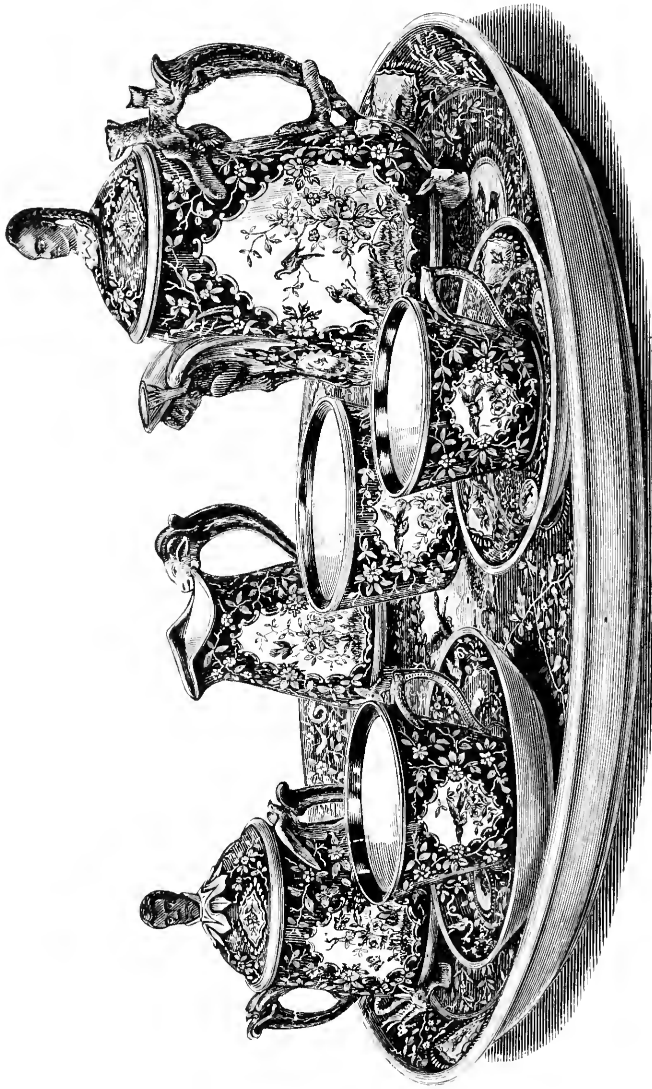

Fig. 28.—Tête-à-tête Set. Union Porcelain Works.

at a higher temperature, and the glaze another, produced at a lower temperature, and not as in porcelain, body and glaze produced at the same time, and at the last and greatest heat.

Fig. 28 shows a *tête-à-tête* set, with head of Chinaman on the cover of the tea-pot, a negro's head on the sugar-bowl, and goat's head on the creamer.

The Union Porcelain Works also manufacture largely hard porcelain insulators and hardware trimmings.

The exquisite fabrications of the Greenpoint works have done much to dispel that unreasonable prejudice which until recently condemned all American productions, of whatsoever merit.

Beautiful as are many of the delicate productions of the potter's skill which are made in molds or by the aid of machinery, clay is a material which yields the most subtle and satisfactory results to the direct touch of the human hand. While printing processes are excellent in their way and indispensable for cheapness, where large production is an element to be considered, they are inadequate to give that breadth and freedom of treatment which constitute true artistic decoration.

While visiting the Centennial, Miss M. Louise McLaughlin, of Cincinnati, was strongly impressed with the beauty of the then novel faience from the Haviland potteries of Limoges, and on her return home she determined to discover, if possible, the processes of decoration. Her experiments, partially successful, extended over a period of nearly three years, and in April, 1879, she gathered around her twelve ladies who were interested in decorative art, and the Pottery Club, which has since exercised such an important influence on the ceramic industry in Cincinnati, was then organized, Miss McLaughlin being elected president and Miss Clara Chipman Newton secretary. Experiments were continued at some of the city potteries, where red, yellow, and white wares were made. On the unburned ware colored clays were applied in the manner of oil paints, and some satisfactory results were obtained.

The ceramic display of Japan at the Philadelphia Exhibition was, more than any other perhaps, the artistic impulse that inspired the venture which resulted in the establishment of the Rookwood Pottery in 1880 by Mrs. Maria Longworth Nicholls. Her experiments were continued at this factory, which, through the liberal patronage of Mr. Joseph Longworth, her father, was furnished with the necessary means for carrying it on until its productions had found a market and it could stand financially alone.

The ware produced here is a true faience, and while the shapes employed are mainly reproductions or variations of classic Greek forms, they possess a marked originality in treatment. The potter's wheel is used as far as possible, on account of giving more freedom and greater variety to the outlines. Mr. Charles Mahar is the only thrower employed at the pottery, and his graceful creations have obtained a world-wide celebrity. The method of casting in vogue is that which consists in pouring liquid clay into plaster molds, which absorb the superabundant moisture from the

adjacent clay. The thin slip is then emptied from the center of the molds, leaving a shell of uniform thickness, which is allowed to stand a while longer before being removed.

The bodies are made of clays found mainly in the Ohio Valley, though samples are being constantly sent to Mr. Joseph Bailey, the superintendent, from all parts of the country. The clays mostly used are a red variety from Buena Vista, Ohio; yellow from Ironton, Ohio; and a whitish or cream-colored clay from Chattanooga—artificially tinted bodies being also used to some extent. The glazing, however, is the most distinctive characteristic of the Rookwood Pottery, which, when applied to the tinted

Fig. 29.—Group of Rookwood Vases.

bodies, produces the effect of rich tones of black, yellow, green, red, brown, and amber, harmoniously blended, of great depth and strength. A number of competent artists are constantly employed in beautifying the wares, the decorations being entirely underglaze. Mr. Kataro Shirayamadani, a Japanese painter of the best school, is doing some of the finest work in Oriental methods. Mr. A. R. Valentien, Mr. M. A. Daly, and others rank among the best American decorators in their particular lines. The above engraving will give a fair idea of some of the forms of vases produced, but no adequate conception of the great beauty of the glazing can be conveyed in black and white.

It is not generally known that the Rookwood Pottery has produced varieties of ware other than the richly glazed pottery which has recently become so familiar through its exhibition in the prominent art-stores of the country. In the earlier years, commencing about 1881, cream-colored ware, with blue prints of

fishes and reptiles, was made. One of these early plates so decorated is here figured. Yellow ware of the finest quality was also produced ten years ago. The highest achievements in glazing are the so-called tiger's-eye and gold-stone, which glisten in the light with an auriferous sheen and all the changing hues of the rainbow.

The Rookwood Pottery was the first in this country to demonstrate the fact that a purely American art-production, in which original and conscientious work is made paramount to commercial considerations, can be appreciated by the American public; for financially this enterprise has recently proved successful, and under the efficient management of Mr. W. W. Taylor, the enthusiastic president of the company, experiments are being constantly prosecuted to discover new bodies, colors, and glazes. At the present time a new building, with improved equipments, is being erected on the summit of Mount Adams, which, it is expected, will be ready for occupancy before the end of the present year.

FIG. 30.—ROOKWOOD PLATE, PRINTED DECORATION.

Within the past few years other potteries have attempted in Cincinnati to make decorated ware, with varying success. One founded by Mr. M. Morgan produced a faience modeled in low relief, in Moorish designs, and the Avon Pottery commenced the manufacture of a ware somewhat resembling the Rookwood; but both were closed after a brief existence.

The Cincinnati Art Pottery Company, Mr. Frank Huntington, president, was organized in 1879, and for several years confined its work to an underglaze faience after the Lambeth style. Later it made Barbotine ware in applied work, but soon dropped this and turned its attention to a more artistic style of overglaze decoration. For a time the "Hungarian faience" was popular with the purchasing public. We are enabled to give an engraving of examples of this (Fig. 31). The latest style of work produced at this factory is called the "Portland blue faience," which consists

of gold and colored decoration on a dark, rich blue ground, of the color of the famous Portland vase. The name *kezonta* has been adopted to designate the wares made here. The origin of the word is interesting. The trade-mark used was the figure of a turtle, and afterward learning that the Indian name for turtle was *kezonta*, the proprietors added this name to the device which

Fig. 31.—"Hungarian Faience." Cincinnati Art Pottery Company.

was employed. Pottery in the biscuit and in blue and white glaze has been sold largely to decorators, the forms being generally modifications of the ancient Roman and Greek. It is with regret we learn that this pottery has been recently closed, the stock of ware on hand having been disposed of by auction.

This, in brief, is the history of the industry which in the past few years has made Cincinnati noted as an art center. In the city Art Museum are about eighty pieces of pottery and porcelain, made between 1875 and 1886, commencing with a small porcelain plate, in blue underglaze decoration, which was painted by Miss McLaughlin in the former year and fired at Greenpoint, Long Island. This collection of early experiments also includes a number of interesting pieces made previous to the establishment of the Rookwood Pottery, by its founder, Mrs. Bellamy Storer, then Mrs. Nicholls.

Some original work of high merit is also being done at the Hampshire Pottery of Messrs. J. S. Taft & Co., Keene, N. H. This pottery was started in 1871 for the manufacture of red ware. Lately the firm has been paying particular attention to art specialties, in new and graceful shapes and novel decorations. The ware is a white, opaque body, covered with a variety of effective glazes. About forty hands are employed, nearly half being decorators. Prof. Edward S. Morse, of Salem, Mass., to whom I am indebted for valuable assistance, first called my attention to these productions.

The Chesapeake Pottery, of Baltimore, Md., was started about

ten years ago by Messrs. D. F. Haynes & Co., and was continued without change until 1887, when the style was altered to The Chesapeake Pottery Company, and again, in 1890, to Haynes, Bennett & Co. Mr. Haynes, who is a practical potter of wide experience and an artist and designer of the highest rank, has invented a number of new bodies and produced a wealth of beautiful designs, which, because of the employment of the printing process in decoration, are to-day beautifying the homes of thousands who could not otherwise enjoy the possession of works of artistic merit. Indeed, the engravings, which have been made especially for these productions, possess so much excellence and are so pleasing in their application to graceful forms that they stand as the exception which proves the rule that the best results can usually be obtained without the aid of mechanical processes. Of the many meritorious designs in high grade dinner sets and the one hundred styles of toilet ware in underglaze printing and overglaze decoration made at this pottery, among the most charming is the Alsatian pattern, made in the new Avalon china body, embellished with the heads of peasants, drawn by Mr. Jesse Shepherd, or scenes from Shakespeare, drawn by Mr. A. Master especially for this set, and printed in vellum tints. The "Merchant of Venice" set is particularly attractive, in which, in a panel on one side, the trial scene is depicted, where Portia says, "The quality of mercy is not strained — it droppeth as the gentle rain from heaven"; and on the other the scene between Antonio, Bassanio, and Shylock, in which the latter exclaims, "And for these courtesies I'll lend you thus much moneys."

Fig. 32.—"Merchant of Venice" Vase.
Chesapeake Pottery.

No less pleasing, though of an entirely different character, is the Arundel ware, which is made entirely from American clays. The body possesses no artificial coloring and is thoroughly vitreous, of a rich olive-brown tint and susceptible of fine finish and delicate relief work. Being made entirely of native materials, it has been named after one of the titles and estates of Lord Balti-

more. This body is made into many useful and decorative shapes, such as jugs, *jardinières*, vases, etc. Pieces of this ware may be seen in Fig. 33. In addition to these productions, the Chesapeake Pottery has turned out ornamental flower-pots, Parian cattle-head plaques in high relief, modeled by Mr. James Priestman, of Boston, from studies of typical animals in the noted herd of Mr. Harvey Adams; also two interesting bas-reliefs representing Winter and Summer, in Parian, the latter modeled by Mr. Priestman and the former by an English artist.

The Clifton ware from this manufactory belongs to the majolica family, and is said to equal, if not surpass, in body the famous Wedgwood ware of the same class.

FIG. 33.—"ARUNDEL" WARE. Chesapeake Pottery.

The ivory ware possesses a body of a soft ivory tint, made from native clays, without the addition of coloring either in body or glaze, whose soft grain and texture render it peculiarly adapted for free treatment and tasteful decoration. Medallions in various colored pastes, on bodies of different tints, which are baked at one firing, have been compared favorably with some of the fine wares made at Etruria, the result of years of intelligent study and experiment in American materials. Many other bodies of equal merit have been invented at this factory, but we have not the space to dwell upon them.

No one of our potters has done so much to beautify the wares for daily use in the household as Mr. Haynes, or accomplished more in the direction of elevating and refining the tastes of the masses, which he considers of even greater importance than the production of a few fine pieces which could only be within the reach of the wealthy. That he has succeeded in this laudable effort is amply demonstrated by the extent to which many of his designs have been copied both at home and abroad.

TILES.—The history of the ceramic art in America would not

be complete without a brief review of the manufacture of ornamental tiles and architectural terra-cotta, which, although extending over only about two decades, furnishes an instance of marvelously rapid development.

As early as 1832, or thereabout, plain fire-brick and tile were made by the American China Manufactory in Philadelphia, then operated by Messrs. Tucker & Hemphill. They advertised these products as being "of a superior quality, manufactured in part from the materials of which the china is composed. These have been proved, by competent judges, to be fully equal to the best Stourbridge brick," which have been celebrated for their excellence for nearly a century and a half. The fire-clays of the Stourbridge district have been used for upward of three hundred years by British manufacturers.

The European exhibits of fancy wall and floor tiles at the Philadelphia Exhibition awakened the American ceramists to a full realization of their insignificance in this broad field, and the majority of ornamental tile works in this country have been established since that great industrial event. With the exception of roofing tiles, Americans made there no exhibit of consequence in this department of the fictile art. As early as 1871 or 1872, however, Messrs. Hyzer & Lewellen, of Philadelphia, had been experimenting in geometrical tiling, and I have before me some interesting examples of these early attempts. Their first experiments were directed to the manufacture of encaustic tiles of geometrical shapes—square, diamond, and triangular—with natural and artificially colored American clays, mainly buff, red, and black, the designs being inlaid to the depth of about a quarter of an inch. While these efforts proved partially successful, the wet clay method employed at that time was unsatisfactory, because the shrinkage was found to be irregular and the pieces came from the kiln of different thicknesses. The next experiments were made by the damp-dust process, which has been employed ever since. The accompanying illustration will show two forms of geomet-

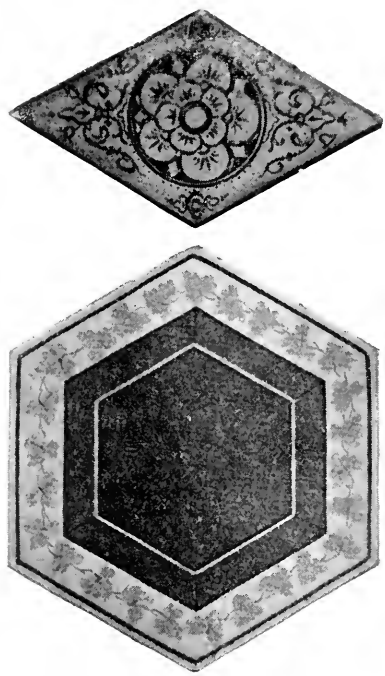

Fig. 34.—Some of the First Fancy American Tiles. Hyzer and Lewellen.

rical wall tiles which were made previous to 1876. They are plain tiles of yellow clay, of great hardness, the glaze being also hard and entirely free from "crazing," and fully equal to anything of the kind which has since been produced. The hexagonal specimen figured is decorated with painted designs above the glaze, consisting of a green vine on a buff ground, with a red center outlined in black. The lozenge-shaped example is painted with a black device on a lemon ground. Later, several patterns of embossed unglazed mantel tiles, in conventional decoration, were produced, but the manufacture of ornamental tiles was only carried on a short time. At present they make plain geometrical floor tiles of different colored bodies and of exceeding hardness. The clay used is fine and homogeneous, and when burned almost approaches stone-ware. The firm also manufactures fire-brick, dental muffles, and stove-linings.

Furnace tests of the standing-up power of the best-known fire-bricks, instituted by the Second Geological Survey of Pennsylvania in 1876, at Harrisburg, showed that the productions of Messrs. Hyzer & Lewellen were superior, in heat-resisting qualities, to all others that were submitted for examination.

Scarcely two years after the Centennial, Mr. John G. Low, of Chelsea, Mass., who had finished a course of several years in the art schools of Paris, and had recently become interested in the manufacture of pottery, formed a copartnership with his father, Hon. John Low, and immediately commenced the erection of a tile-factory in his native place. Less than a year and a half after the works were started we find the firm competing with English tile-makers at the exhibition at Crewe, near Stoke-on-Trent, which was conducted under the auspices of the Royal Manchester, Liverpool, and North Lancashire Agricultural Society, one of the oldest societies in England. There they won the gold medal, over all the manufacturers of the United Kingdom, for the best collection of art tiles exhibited. This record, probably unsurpassed in ceramic history, serves to illustrate the remarkably rapid development of an industry new in America, but old in the East, and shows the resources at command of the American potter.

In 1883 Hon. John Low retired from the firm, and Mr. John F. Low, son of the founder, became associated with his father, under the style of J. G. & J. F. Low.

Mr. Arthur Osborne, who has designed the majority of the tiles produced here, is a talented artist of the older schools of art, whose conceptions are chaste and classic and possess marked originality.

A novel method was resorted to by Mr. Low in the embellishment of his earlier productions, which he has patented, and which he calls the "natural" process. To secure accurate impressions

of delicate objects, such as grasses, leaves, lace, etc., the article to be represented was placed on the surface of the unburned tile and forced into the clay by means of a press. Such intaglios, plainly showing every small detail of marking, were utilized as molds for forming the raised designs on tiles, which were called "natural tiles."

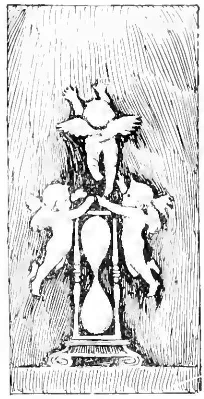
Fig. 35.—A "Low" Tile, "The Flying Moments." By Osborne.

In the high-relief tiles the undercutting is done by hand after the designs have been stamped in the press. Among Mr. Osborne's designs are ideal heads, mythological subjects, portraits of prominent men, Japanese sketches, and an almost endless variety of animal, bird, and floral studies. His plastic sketches, on a larger scale, are particularly meritorious, some of the most pleasing being a group of sheep in a pasture, a drove of swine, entitled "Late for Dinner," a herd of cows wending their way homeward, and "The Old Windmill." A beautiful conceit is the "Flying Moments," in which three Cupids hover around an hour-glass, one being depicted in the act of winging his way upward (see Fig. 35). These works also make stove tiles, calendar tiles, clothes-hooks, paper-weights, inkstands, and pitchers in plain colors, enameled, and glazed. They at one time also manufactured tile stoves. Lately the Lows have been making a specialty of the manufacture of art-tile soda fountains, in which work Mr. Osborne has found a broader field for the exercise of his talents.


Fig. 36.—Panel for Soda Fountain. J. G. & J. F. Low.

The United States Encaustic Tile Works, of Indianapolis, Ind., is the outgrowth of the United States Encaustic Tile Company, which was organized shortly after the Centennial. Five years ago the present proprietors took charge of the works, and are now making encaustic geometrical and relief mantel tiles. So rapidly has the business grown in the past few years that the plant now

includes six bisque and twelve muffle kilns, which are taxed to their utmost capacity. The clays used for white bodies come from South Carolina and Kentucky, and those for dark bodies are obtained from Indiana, the burning being done by means of natural gas. Miss Ruth Winterbotham, who is at present the principal modeler of this factory, has produced many beautiful designs, of which some three and six section panels are probably the most artistic. A series of three mantel panels, representing Dawn, Midday, and Twilight, are particularly deserving of mention, the latter one being shown in the annexed engraving. The method employed in making embossed or relief tiles is that used by all tile works in this country, which was patented by Richard Prosser, in England, in 1840, for making buttons, and shortly after applied by J. M. Blashfield to the manufacture of tiles, called the dust process, which consists in slightly moistening the dry powdered white clay and subjecting it to great pressure in dies containing the designs to be impressed upon them. They are then burned and afterward glazed or enameled in delicate colors. Mr. Robert Minton Taylor, of England, was connected with these works from 1881 to 1883.

Fig. 37. — "Twilight" Tile. United States Encaustic Tile Works. Designed by Miss Winterbotham.

The Beaver Falls Art Tile Company, limited, of Beaver Falls, Pa., was organized in 1886 by Mr. Frank W. Walker, the present secretary and treasurer. These works make a specialty of rectangular and circular stove tiles and manufacture largely fine art relief tiles for wainscoting, hearths, and mantel facings. The present designer is Prof. Isaac Broome, a gentleman of rare artistic ability, a thorough potter, and a sculptor of eminence, who became connected with the works in 1890. In 1878 he was appointed a special commissioner on ceramics at the Paris Exposition and, in conjunction with General McClellan, made a thorough study of the ceramic art as it exists abroad. The varied and extensive knowledge which he has acquired through a life of study has especially fitted him for the work upon which he is now engaged.

After leaving the Ott and Brewer Company he went in 1883 with the Harris Manufacturing Company, now the Trent Tile Company, as modeler, and afterward, in 1886, was instrumental in establishing the Providential Tile Works, of Trenton, N. J., and designed many of their best works. Through his influence the Beaver Falls establishment has made, during the past year and a half, rapid strides in the development of decorative tile manufacture. A complete ceramic color scale has been achieved and a series of glazes produced, of soft, rich tones, a most important result obtained being entire freedom from "crazing," which has already given these works a high reputation. Prof. Broome is an indefatigable worker and a prolific artist, his sculptures being characterized by exquisite conception and beautiful execution. While he has produced many more pretentious works, some of his sim-

Fig. 38.—Beaver Falls Stove Tiles.

ple designs leave nothing to be desired. One of his most highly admired pieces is a six-inch tile with a Grecian figure (Sappho) leaning on a harp. Prof. Broome has also designed some twelve by twelve inch tiles of great merit which will soon be submitted to the public.

The American Encaustic Tiling Company, of Zanesville, Ohio, is the most extensive establishment of the kind in the United States. It manufactures artistic and encaustic tiles, and has placed upon the market some fine pieces of relief work, twelve by eighteen inches in size, among the subjects of which we have seen some female water-carriers of Grecian type. This factory also

makes an intaglio modeled tile, the effect of which, when filled with glaze, is that of a photograph on a smooth surface of clay. The different depths of the engraving regulate the degree of shading, and portraits of individuals have been executed with great fidelity. It has been mainly through the intelligent management of Mr. George A. Stanbery, the general superintendent, with the assistance of Mr. Karl Langenbeck, the efficient chemist of the company, that such marked success has been achieved. The

Fig. 39.—"Sappho." Beaver Falls Art Tile Company. By Broome.

modeling and casting of the dies are the work of Mr. Hermann Mueller, formerly of Coburg, who studied in the Industrial Academy and Preparatory Art School of Nuremberg, and in the Art Academy of Munich. For geometrical designing of encaustic tiles used in flooring and wainscoting the factory employs several competent architects.

The works were projected in 1875 for the manufacture of floor tiles, but in 1880 enameled tiles were added to the products of the factory, and at the present time eleven large kilns are in operation. The city of Zanesville has recently donated a tract of thirty acres to the company, on which an extensive plant is now being erected which will include twenty-eight kilns, to be operated in addition to the present establishment.

The Trent Tile Company, of Trenton, N. J., established about 1882, is now making dull lustered tiles in *alto-relievo*, which process has been patented. This style of finish forms a striking contrast to the glazed and enameled varieties also made here. Effect-

ive panels for mantel facings, six by eighteen inches, in one piece, are also produced. One of these is a center panel in a pastoral facing, which was modeled by Mr. William W. Gallimore, from a sketch in black and white by an artist of the name of Cooper. The scene represents a shepherd boy playing his pipes to his flock.

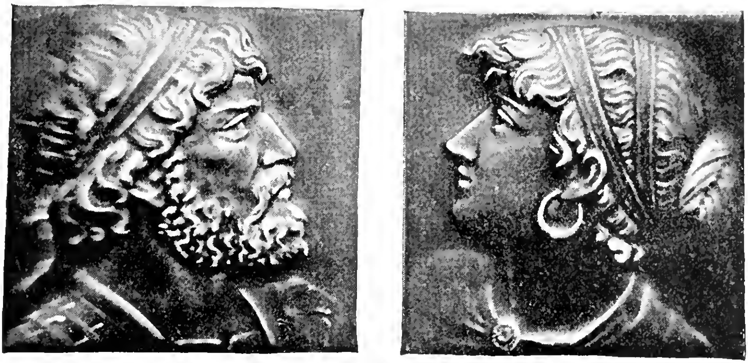

Fig. 40.—Dull Finished Tiles. Trent Tile Company.

The peculiar treatment of this piece, in which the sheep in the foreground are in relief and those in the distance in intaglio, is particularly pleasing. Mr. Gallimore, the present modeler for this company, was in his earlier days connected with the Belleek potteries in Ireland, where he lost his right arm by the bursting of a gun. He afterward modeled for Mr. William Henry Goss, at London Road, Stoke-upon-Trent, where, under the supervision of the latter, he produced some admirable Parian busts, including that of the late Mr. Llewellynn Jewitt, which serves as the frontis-

Fig. 41.—Pastoral Panel. Trent Tile Company.

piece to the latter's Ceramic Art in Great Britain. Since the loss of his arm, Mr. Gallimore has done his modeling with his left hand, and he has accomplished better work with one arm than he did when in possession of both. He has been with the Trent Company about four years. This company has now six biscuit kilns, and, in addition to the wares made for the general trade, is turning out considerable work of a special nature.

The Providential Tile Works, of Trenton, make glazed tiles, plain and in relief. At one time they experimented in different-colored glazes on the same piece, the raised portions being of a different tint from the ground, and some good results were obtained by this treatment. Underglaze decoration was also employed to

Fig. 42.—Tile Panel, "Indolence." Providential Tile Works.

some extent formerly, and some fine work in that line was produced, but both of these styles have been abandoned as unsuited to the market. The present designer and modeler is Mr. Scott Callowhill, who came to this country about six years ago from the Royal Worcester Works, England, where, with his brother, Mr. James Callowhill, now of Roslindale, Mass., he had charge of two of the principal decorating-rooms in which the finer class of decoration, in raised paste and gold bronze, was done. He also, while in England, worked for the Doultons, at Lambeth. Some of their newest designs are relief tiles, measuring six by twelve inches, and among their most popular pieces are hunting panels for mantel facings, with such subjects as fighting bucks, stags' heads, sportsmen, and dogs.

One of the most recent applicants for public favor is the Cambridge Art Tile Works, of Covington, Ky., which commenced business in 1887. They are producing high grade enameled and embossed goods of various shapes and in size from one half inch square to six by eighteen inches. The glazes employed are remarkably free from "crazing." The designer and modeler is Mr. Ferdinand Mersman, who studied at the Academy of Fine Arts in Munich. A pair of six by eighteen inch panels, which have just been completed, are examples of exquisite modeling, being copies of Hans Makart's celebrated paintings "Night" and "Morning."

At Anderson, Ind., the Columbia Encaustic Tile Company is

producing inlaid and embossed art tiles, and at other points tile-factories are in operation, but we must content ourselves with this very incomplete sketch of the principal establishments in this country.

In the manufacture of printed, inlaid, and relief tiles, America has advanced rapidly, but in the production of hand-painted art tiles she is sadly deficient. This is a branch of the art that must be developed through the influence of our mechanical art schools, which are paving the way for an early revolution in the ceramic industry in the United States.

Various tile machines have been designed for the manufacture of tiles from dust or semi-dry clay, but we are unable here to reproduce more than one. Fig. 43 shows a screw press, made by Mr. Peter Wilkes, of Trenton, for the Trent Tile Company, and will give an excellent idea of the principle on which the majority of such machines are operated. This forms tiles six inches to twelve inches square, the die being placed between the "push-up" and "plunger." It can also be used for making plates, oval dishes, and other ware.

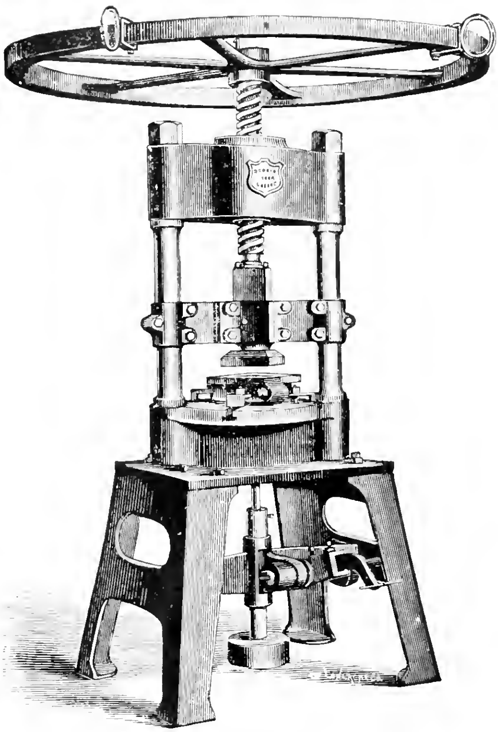

FIG. 43.—THE WILKES SCREW TILE PRESS.

ARCHITECTURAL TERRA COTTA.—It is interesting to note what the fifth edition of the Encyclopædia Britannica, published in 1815, contains relative to this subject: "Worlidge, and others after him, have endeavored to excite brick-makers to try their skill in making a new kind of brick, or a composition of clay and sand, whereof to form window-frames, chimney-pieces, door-cases, and the like. It is to be made in pieces, fashioned in molds, which, when burnt, may be set together with a fine red cement, and seem as one entire piece. The thing should seem feasible." And so we shall find that it was.

Terra cotta, the most enduring of all building materials, has

been used to a greater or lesser extent from a high antiquity in continental Europe, and in England terra-cotta trimmings were used in building as early as the fifteenth century. In the United States this material does not seem to have been introduced until after 1850. Experiments were made in this direction in 1853 by

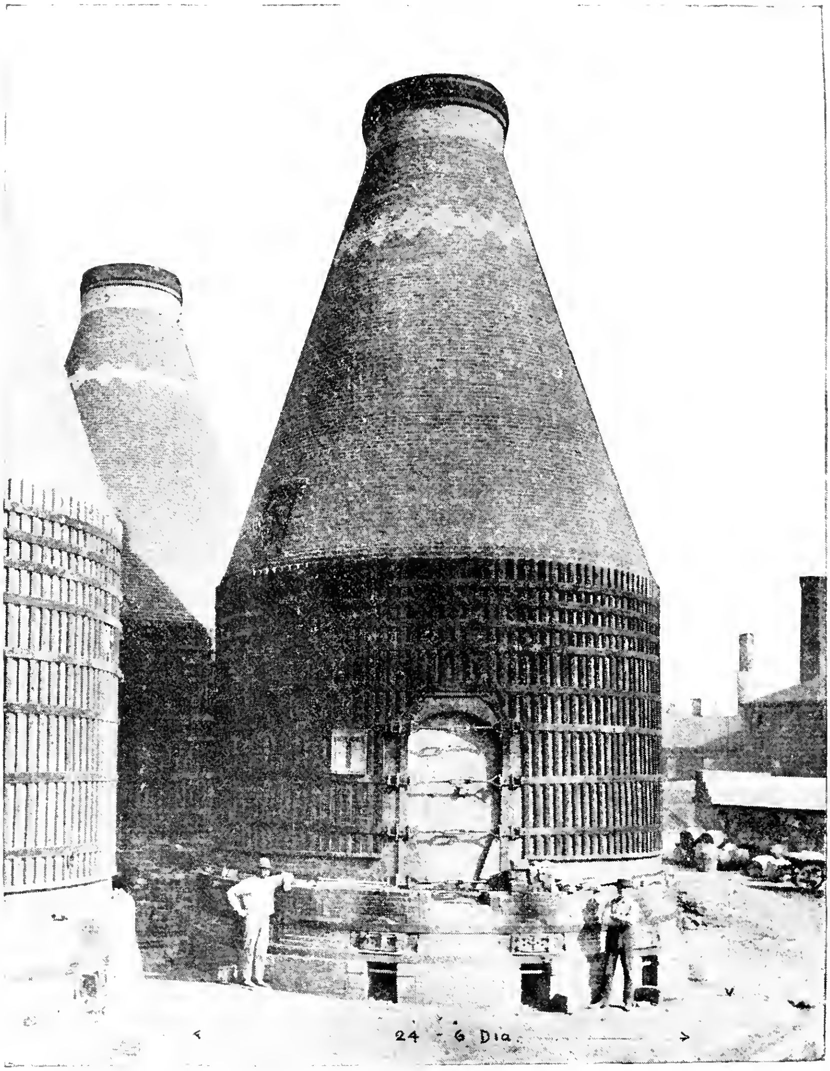

Fig. 44.—Three Kilns. Perth Amboy Terra Cotta Company.

Mr. James Renwick, a prominent New York architect, but the innovation was not received with favor by builders. In 1870 the Chicago Terra Cotta Company brought over from England Mr. James Taylor, superintendent of the well-known works which

were established by Mr J. M. Blashfield in 1858. By the introduction of the English methods, the Chicago establishment soon turned out better work than had been produced before in the United States.

The Perth Amboy Terra Cotta Company was incorporated in 1879, and at once embarked in the manufacture of large designs for architectural purposes from clay obtained from the neighboring deposits. The plant of this company has expanded so rapidly that at present it includes twenty-two kilns, some of them measuring forty-eight and one third feet in height and twenty-four and one sixth in diameter, which are said to be the largest of the kind on this continent, if not in the world.

Fig. 45.

The company has in its employ a number of eminent artists in this particular line, and has furnished terra-cotta details for many prominent buildings throughout the country. Of these we may mention Young Maennerchor Hall, Philadelphia; Ponce de Leon Hotel, St. Augustine, Florida; Biological Laboratory, Princeton College; and Central School, Ironton, Ohio. Fig. 45 represents a large panel in a warehouse in Jersey City, and Fig. 46 a bas-relief in the St. Anthony Club House, Philadelphia.

Since about 1880 the demand for architectural terra cotta has rapidly increased, and to-day many manufactories are in operation in various parts of the country. In the latter part of 1885 the New York Architectural Terra Cotta Company was organized, and the services of Mr. James Taylor secured as superintendent. The works at Long Island City have furnished designs for more than two thousand buildings, scattered throughout the principal cities of the Union. They have lately succeeded in producing a pure white terra cotta, which is said to be fully equal to the red in durability and hardness, and at present are using this latest invention, in combination with buff bricks, in the rebuilding of Harrigan's Theatre, New York. The effect is novel and pleasing. Other architectural terra-cotta works have also been experimenting recently in the same direction, and it is now only a question of a short time when the more perishable marble, as a building material, will be superseded by this more enduring substitute. Having eliminated the red coloring matter from the composition, it would seem possible, by the introduction of other tints, to produce terra cotta in yellow, blue, or any shade desired. The possibilities in this direction appear almost limitless.

Fig. 46.

Fig. 47.—Panel in Residence of Mr. George Alfred Townsend, Gapland, Me. New York Architectural Terra Cotta Company.

The Indianapolis Terra Cotta Company, located at Brightwood, Ind., commenced business under its present management in 1886. Mr. Joseph Joiner, a gentleman of large experience in this field, and a highly qualified architect, superintends the manufacturing department.

In the same year Messrs. Stephens & Leach started a factory for architectural terra cotta in West Philadelphia, and later the firm name was changed to Stephens, Armstrong & Conkling.

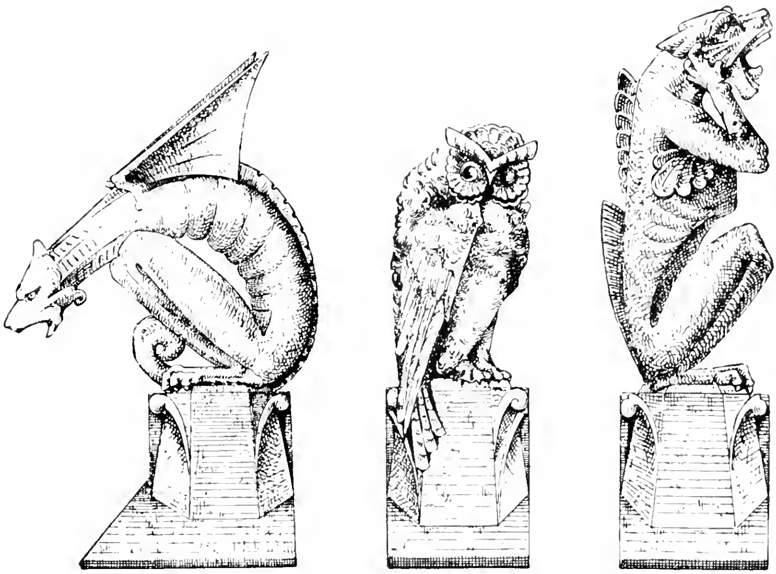

Fig. 48.—Finials. Indianapolis Terra Cotta Company.

During the five years of the works' existence it has furnished material for hundreds of important structures in Philadelphia and other cities, of which particular mention may be made of panels and gable work in the library of the University of Pennsylvania, and the Drexel Institute, now being erected in West Philadelphia. A series of animal-head medallions, in high relief, are particularly excellent, and some bas-relief portraits of eminent men, modeled by such sculptors as H. J. Ellicott, John Boyle, and E. N. Conkling, are among their best productions. A medallion of Columbus by Mr. Conkling, and a Cupid and floral panel by Thomas Robertson, are here represented. Admirable work is also being produced by other establishments in Boston, Chicago, and most of our larger cities.

Fig. 49.—Medallion of Columbus.

Recently considerable attention has been given to the construction of brick and tile kilns on scientific principles. Many improved kilns, both on the up-draft and the down-draft systems, have been invented. Art tiles and architectural terra cotta are being burned in up-draft kilns with closed tops, or muffled kilns, in which "saggers," or fire-clay boxes, are used to protect the pieces from direct contact with the flames. Mr. W. A. Eudaly,

Fig. 50.—Floral Panel.

of Cincinnati, has perfected a down-draft kiln which is arranged with compartments in the bottom, which are provided with two separate and distinct sets of flues, one of which carries a portion of the heat into the kiln, and the other conducts a portion from the kiln to stacks or chimneys built in the main wall. The heat is thus divided as it enters the kiln or leaves the furnace, a portion going up through the bags to the ware at the top, while another part surrounds the ware at the bottom of the kiln, securing uniformity of burning and perfect consumption of fuel and

gases. By this method tiles and architectural terra cotta, as well as enamel brick, enameled when green, and thus requiring only one firing, are successfully burned without the use of saggers. Mr. Eudaly also constructs a square down-draft kiln on precisely the same principles, but better adapted to the manufacture of common brick, fire-brick, and sewer-pipe in large quantity, the brick-kilns having a capacity of 80,000 to 300,000, the inside arrangement being such that the heat can be driven to any part of the kiln without altering the fire in the furnace. Thus all the bricks are burned of equal hardness, a vast improvement over the old-fashioned clamp kilns with open tops.

With the failure of natural gas supplies in the West, artificial fuel-gas is destined to become the principal agency in the firing of ceramic products. Its extreme cheapness and perfect adaptability to the needs of the potter will insure its extensive use in the near future. There seems to be no reason to doubt that it will, ere long, supersede wood and coal as a kiln fuel.

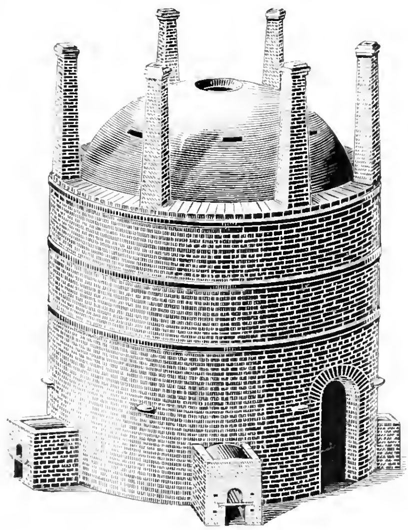

Fig. 51.—The Eudaly Kiln.

At the last convention of the United States Potters' Association, held in Washington in January, 1891, it was decided to open a Pottery School with the co-operation of the Pennsylvania Museum and School of Industrial Art, at Philadelphia, under the efficient management of Prof. L. W. Miller, where designing, modeling, and chemistry shall be taught, and the student fully equipped for usefulness as a practical potter and artist artisan.

American potters have much to learn, but the day is not far distant when, as is the case with other industries, we shall lead the world in this, the oldest and most interesting of the mechanical arts. The Columbian Exposition of 1893 will serve as a powerful impetus toward this end, and the World's Fair Committee appointed by the United States Potters' Association, and composed of such progressive potters as Messrs. J. N. Taylor, Homer Laughlin, J. H. Brewer, James Moses, E. M. Pearson, D. F. Haynes, and C. E. Brockman, will insure a creditable representation of American goods in this branch of the Exhibition.

It is true that American manufacturers have excelled the Eng-

lish in branches of the art which they have seriously undertaken. Our copies of certain European wares are fully equal to the originals, and in some directions are superior. It only requires the proper appreciation and encouragement of the public to furnish the incentive to a broader application of the principles which have been mastered by American artists, in order to produce the best that has been attempted by the older French, Italian, and German schools. In our reproductions of the thin Belleek ware of Ireland, the Limoges faience of the Havilands, and specialties of other Continental factories, we not only equal them, but often excel them, in delicacy of form and beauty of glaze and decoration. Our relief tiles surpass in artistic merit anything produced abroad of a similar character, having won the first premium over British wares long before we brought them to their present state of perfection. Our architectural terra cottas have, within the past few years, left England behind, and, could the absurd prejudice against home art and native work be overcome America would soon lead the world in ceramic fabrics of every nature. Americans are commencing to discriminate between the meritorious and the meretricious, and to decide in favor of American goods. Having the richest mines in the world, from which the best materials are

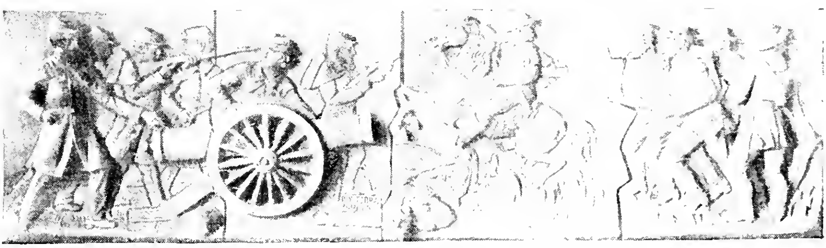

Fig. 52.—Military Panel, G. A. R. Memorial Hall, Wilkesbarre, Pa. New York Architectural Terra Cotta Company.

procured, the most talented artists, and the most highly cultured public, there is no reason why we should not compete with the entire globe in the manufacture of artistic pottery and porcelain. It has been repeatedly stated that our artists are imitative, rather than inventive; but while this may, to a certain extent, be true, and some of our potters have been content to creditably reproduce the well-known wares of foreign schools, others have directed their attention to the perfection of distinctively original products, which, for richness of glazing, excellence of body, and beauty of conception, will rank with the best productions of Europe. The inventive genius of American potters has a vast and practically limitless field for experimenting, and the art schools which have sprung up in our principal cities may in time produce a second Robbia, a worthy successor to Palissy, or an emulator of that prince of potters, Josiah Wedgwood.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XIV. THEOLOGY AND POLITICAL ECONOMY.

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AMONG questions on which the supporters of right reason in political and social science have only conquered theological opposition after centuries of war, is the taking of interest on loans. In hardly any struggle has rigid adherence to the letter of our sacred books been more prolonged and injurious.

Certainly, if the criterion of truth, as regards any doctrine, be that of St. Vincent of Lerins, that it has been believed in the Church "always, everywhere, and by all," then on no point may a Christian of these days be more sure than that every savings institution, every loan and trust company, every bank, every loan of capital by an individual, every means by which accumulated capital has been lawfully lent even at the most moderate interest, to make men workers rather than paupers, is based on deadly sin.

The early evolution of the belief that taking interest for money is sinful presents a curious working-together of metaphysical, theological, and humanitarian ideas.

In the great center of ancient Greek civilization, the loaning of money at interest came to be accepted at an early period as a condition of productive industry, and no legal restriction was imposed. In Rome there was a long process of development. The greed of creditors in early times led to laws against the taking of interest, but, though these lasted long, that strong practical sense, which gave Rome the empire of the world, substituted finally, for this absolute prohibition, the establishment of rates fixed by law. Yet many of the leading Greek and Roman thinkers opposed this practical settlement of the question, and, foremost of all, Aristotle. In a metaphysical way he declared that money is by nature "barren"; that the birth of money from money is therefore "unnatural"; and hence that the taking of interest is to be censured and hated. Plato, Plutarch, both the Catos, Cicero, Seneca, and various other leaders of ancient thought arrived at much the same conclusion—sometimes, from sympathy with oppressed debtors; sometimes, from hatred of usurers; sometimes, from simple contempt of trade.

From these sources there came into the early Church the germ of a theological theory upon the subject.

But far greater was the stream of influence from the Jewish and Christian sacred books. In the Old Testament stood a multitude of texts condemning usury, the term usury meaning any

taking of interest; the law of Moses, while it allowed usury in dealing with strangers, forbade it in dealing with Jews. In the New Testament stood the text in St. Luke, "Lend, hoping for nothing again." These texts seemed to harmonize with the Sermon on the Mount, and with the most beautiful characteristic of primitive Christianity; its tender care for the poor and oppressed: hence we find, from the earliest period, the whole weight of the Church brought to bear against the taking of interest for money.*

The great fathers of the Eastern Church, and among them St. Basil, St. Chrysostom, and St. Gregory of Nyssa; the fathers of the Western Church, and among them Tertullian, St. Ambrose, St. Augustine, and St. Jerome joined most earnestly in this condemnation. St. Basil denounces money at interest as a "fecund monster," and says, "The divine law declares expressly, 'Thou shalt not lend on usury to thy brother or thy neighbor.'" St. Gregory of Nyssa calls down on him who lends money at interest the vengeance of the Almighty. St. Chrysostom says: "What can be more unreasonable than to sow without land, without rain, without plows? All those who give themselves up to this damnable culture shall reap only tares. Let us cut off these monstrous births of gold and silver; let us stop this execrable fecundity." Lactantius called the taking of interest "robbery." St. Ambrose declared it as bad as murder. St. Jerome threw the argument into the form of a dilemma, which was used as a weapon against money-lenders for centuries. St. Anselm proved from the Scriptures that the taking of interest is a breach of the Ten Commandments. Pope Leo the Great solemnly adjudged the same offense to be a sin worthy of severe punishment.†

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* On the general allowance of interest for money in Greece, even at high rates, see Böckh, Public Economy of the Athenians, translated by Lamb, Boston, 1857, especially chaps. xxii, xxiii, and xxiv of Book I. For view of usury taken by Aristotle, see his Politics and Economics, translated by Walford, p. 27; also Grote, History of Greece, vol. iii, chap. xi. For summary of opinions in Greece and Rome, and their relation to Christian thought, see Böhm-Bawerk, Capital and Interest, translated by Smart, London, 1890, chap. i. For a very full list of Scripture texts against the taking of interest, see Pearson, The Theories of Usury in Europe, 1100–1400, Cambridge (England), 1876, p. 6. The texts most frequently cited were: Leviticus, xxv, 36, 37; Deuteronomy, xxiii, 19 and 26; Psalms, xv, 5; Ezekiel, xviii, 8 and 17; St. Luke, vi, 35. For a curious modern use of them, see D. S. Dickinson's speech in the Senate of New York in vol. i of his collected writings. See also Lecky, History of Rationalism in Europe, vol. ii, chap. vi; and, above all, as the most recent historical summary by a leading historian of political economy, Böhm-Bawerk as above.

† For St. Basil and St. Gregory of Nyssa, see French translation of these diatribes in Homélies contre les Usuriers, Paris, Hachette, 1861–'62, especially p. 30 of St. Basil. For some doubtful reservations by St. Augustine, see Murray, History of Usury. For St. Ambrose, see the De Officiis, lib. iii, cap. ii, in Migne, Patrologia, tome xvi; also the De Tobia, in Migne, tome xiv. For St. Augustine, see De Bapt. contra Donat, lib. iv, cap.

This unanimity of the fathers of the Church brought about a crystallization of hostility to interest-bearing loans into numberless decrees of popes and councils and kings and legislatures throughout Christendom during more than fifteen hundred years; and the canon law was shaped in accordance with these. At first these were more especially directed against the clergy, but we soon find them extending to the laity. These prohibitions were enforced by the Council of Arles in 314, and a modern church apologist insists that every great assembly of the Church, from the Council of Elvira in 306 to that of Vienne in 1311, inclusive, solemnly condemned lending money at interest. The greatest rulers under the sway of the Church—Justinian, in the Empire of the East; Charlemagne, in the Empire of the West; Alfred, in England; St. Louis, in France—yielded fully to this dogma. In the ninth century Alfred went so far as to confiscate the estates of money-lenders, denying them burial in consecrated ground; and similar decrees were made in other parts of Europe. In the twelfth century the Greek Church seems to have relaxed its strictness somewhat, but the Roman Church grew more severe. Peter Lombard, in his Sentences, a great source of orthodox theology, makes the taking of interest purely and simply theft. St. Bernard, reviving religious earnestness in the Church, took the same view. In 1179 the Third Council of the Lateran decreed that impenitent money-lenders should be excluded from the altar, from absolution in the hour of death, and from Christian burial. Pope Urban III reiterated the declaration that the passage in St. Luke forbade the taking of any interest whatever. Pope Alexander III declared that the prohibition in this matter could never be suspended by dispensation.

In the thirteenth century Pope Gregory IX dealt an especially severe blow at commerce by his declaration that even to advance on interest the money necessary in maritime trade was damnable usury. This idea was still more firmly fastened upon the world by the two greatest thinkers of the time: first, by St. Thomas Aquinas, who knit it into the mind of the Church by the use of the Scriptures and of Aristotle; and next by Dante, who pictured money-lenders in one of the worst parts of hell.

At the beginning of the fourteenth century the Council of

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ix, in Migne, tome xliii. For Lactantius, see Lact., Opera, Leyden, 1660, p. 608. For Cyprian, see his Testimonies against the Jews, translated by Wallis, Book III, article 48. For St. Jerome, see his Com. in Ezekiel, xviii, 8, in Migne, tome xxv, pp. 170 *et seq.* For Leo the Great, see his Letter to the Bishops of various provinces of Italy, cited in Jus Can., cap. vii, can. xiv, qu. 4. For very fair statements of the attitude of the fathers on this question, see Addis and Arnold, Catholic Dictionary, London, 1884, and Smith and Cheetham, Dictionary of Christian Antiquities, Hartford, 1880, in each under article Usury.

Vienne, presided over by Pope Clement V, declared that if any one "shall pertinaciously presume to affirm that the taking of interest for money is not a sin, we decree him to be a heretic, fit for punishment." This infallible utterance bound the dogma with additional force on the conscience of the universal Church.

Nor was this a doctrine enforced only by rulers; the people were no less strenuous. In 1390 it was enacted by the city authorities of London that "if any person shall lend or put into the hands of any person gold or silver to receive gain thereby, such person shall have the punishment for usurers." And in the same year the Commons prayed the king that the laws of London against usury might have the force of statutes throughout the realm.

In the fifteenth century the Council of the Church at Salzburg excluded from communion and burial any who took interest for money, and this was a very general rule throughout Germany.

An exception was, indeed, sometimes made: some canonists held that Jews might be allowed to take interest, since they were to be damned in any case, and their monopoly of money-lending might prevent Christians from losing their souls by going into the business. Yet even the Jews were from time to time punished for the crime of usury, and, both as regards Jews and Christians, punishment was bestowed on the dead as well as the living; the bodies of dead money-lenders being here and there dug up and cast out of consecrated ground.

The popular preachers constantly declaimed against all who took interest. The mediæval anecdote books for pulpit use are especially full on this point. Jacques de Vitry tells us that demons on one occasion filled a dead money-lender's mouth with red-hot coins; Cæsar, of Heisterbacho, declared that a toad was found thrusting a piece of money into a dead usurer's heart; in another case, a devil was seen pouring molten gold down a dead money-lender's throat.*

* For an enumeration of councils condemning the taking of interest for money, see Liégois, Essai sur l'histoire et la législation de l'usure, Paris, 1865, p. 78; also the Catholic Dictionary as above. For curious additional details and sources regarding mediæval horror of usurers, see Ducange, Glossarium, etc., article Caorcini. The date, 306, for the Council of Elvira is that assigned by Hefele. For the decree of Alexander III, see citation from the Latin text in Lecky. For a long catalogue of ecclesiastical and civil decrees against taking of interest, see Petit, Traité de l'Usure, Paris, 1840. For the reasoning at bottom of this, see Cunningham, Christian Opinion upon Usury, London, 1884. For the Salzburg decrees, see Zillner, Salzburgische Culturgeschichte, p. 232; and for Germany generally, see Neumann, Geschichte des Wuchers im Deutschland, Halle, 1865, especially p. 22 *et seq.*; also Roscher, National Oeconomie. For effect of mistranslation of the passage of Luke in the Vulgate, see Döllinger, p. 170, and especially pp. 224, 225. For the capitularies of Charlemagne against usury, see Liégois, p. 77. For Peter Lombard, see his Lib. Sententiarum, lib. iii, dist. XXXVII, 3. For St. Thomas Aquinas, see his works, Migne, vol.

This theological hostility to the taking of interest was imbedded firmly in the canon law. Again and again it defined usury to be the taking of anything of value beyond the exact original amount of a loan; and under sanction of the universal Church it denounced this as a crime and declared all persons defending it to be guilty of heresy. What this meant the world knows but too well.

The whole evolution of European civilization was greatly hindered by this conscientious policy. Money could only be loaned in most countries at the risk of incurring odium in this world and damnation in the next; hence there was but little capital and few lenders. The rates of interest became at times enormous; as high as forty per cent in England, and ten per cent a month in Italy and Spain. Commerce, manufactures, and general enterprise were dwarfed, while pauperism flourished.

Yet worse than these were the moral results. Doing what one believes is evil is only second in bad consequences to doing what is really evil; hence, all lending and borrowing, even for the most legitimate purposes and at the most reasonable rates, tended to debase the character of both borrower and lender. The prohibition of interest for the use of money in continental Europe promoted luxury and discouraged economy, the rich, who were not engaged in business, finding no easy way of employing their savings productively.

One evil effect is felt in all parts of the world to this hour. The Jews, so strong in will and acute in intellect, were virtually drawn or driven out of all other industries or professions by the theory that their race, being accursed, was only fitted for the accursed profession of money-lending.*

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iii, Paris, 1889, question 78, pp. 586 *et seq.*, citing the Scriptures and Aristotle, and especially developing Aristotle's metaphysical idea regarding the "barrenness" of money. For a very good summary of St. Thomas's ideas, see Pearson, pp. 30 *et seq.* For Dante, see in Canto XI of the Inferno a revelation of the amazing depth of the hostility to the taking of interest. For the London law of 1390 and the petition to the king, see Cunningham, Growth of English Industry and Commerce, pp. 210 and 326; also the Abridgment of the Records in the Tower of London, p. 339. For the theory that Jews, being damned already, might be allowed to practice usury, see Liégois, Histoire de l'Usure, p. 82. For St. Bernard's view, see Epist. CCCLXIII, in Migne, tome clxxxii, p. 567. For ideas and anecdotes for preachers' use, see Joannes de San Geminiano, Summa de Exemplis, Antwerp, 1629, fol. 493, *a*; also an edition of Venice, 1584, pp. 132 and 159; but especially for multitudes of examples, see the Exempla of Jacques de Vitry, edited by Prof. T. F. Crane, of Cornell University, London, 1890, pp. 203 *et seq.* For the canon law in relation to usance, see a long line of authorities cited in Die Wucherfrage, St. Louis, 1869, pp. 92 *et seq.*, and especially Decret. Gregor., lib. v, lit. 19, cap. iii, and Clementin, lib. v, lit. 5, sec. 2; see also the Corpus Juris Canonici, Paris, 1618, pp. 227, 228. For the position of the English Church, see Gibson's Corpus Juris Ecclesiastici Anglicani, pp. 1070, 1071, and 1106.

* For evil economic results, and especially for the rise of the rate of interest in England and elsewhere at times to forty per cent, see Cunningham, Growth of English Industry and Commerce, Cambridge, 1890, p. 189; and for its rising to ten per cent a month,

These evils seemed so manifest, when trade began to revive throughout Europe in the fifteenth century, that most earnest exertions were put forth to induce the Church to change its position.

The first important effort of this kind was made by John Gerson. His general learning made him Chancellor of the University of Paris; his sacred learning made him the leading orator at the Council of Constance; his piety led men to attribute to him The Imitation of Christ. Shaking off theological shackles, he declared: "Better is it to lend money at reasonable interest, and thus to give aid to the poor, than to see them reduced by poverty to steal, waste their goods, and sell at a low price their personal and real property."

But this idea was at once buried beneath citations from the Scriptures, from the fathers, councils, popes, and the canon law. Even in the most active countries there seemed to be no hope. In England, under Henry VII, Cardinal Morton, the lord chancellor, addressed Parliament, asking it to take into consideration loans of money at interest. The result was a law which imposed on lenders at interest a fine of a hundred pounds besides the annulment of the loan; and, to show that there was an offense against religion involved, there was added a clause "reserving to the Church, notwithstanding this punishment, the correction of their souls according to the laws of the same."

Similar enactments were made by civil authority in various parts of Europe; and just when the trade, commerce, and manufactures of the modern epoch had received an immense impulse from the great series of voyages of discovery by such men as Columbus, Vasco da Gama, Magellan, and the Cabots, this barrier against enterprise was strengthened by a decree from no less enlightened a pontiff than Leo X.

The popular feeling warranted such decrees. As late as the end of the middle ages, we find the people of Piacenza dragging the body of a money-lender out of his grave in consecrated ground and throwing it into the Po, in order to stop a prolonged rain-storm; and outbreaks of the same spirit are frequent in other countries.*

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see Bédarride, Les Juifs en France, en Italie et en Espagne, p. 220. See also Hallam's Middle Ages, London, 1853, pp. 401, 402. For the evil moral effects of the Church doctrine against taking interest, see Montesquieu, Esprit des Lois, lib. xxi, chap. xx. See also Sismondi, cited in Lecky. For the trifling with conscience, distinction between "consumptibles" and "fungibles," "possessio" and "dominium," etc., see Ashley, English Economic History, New York, 1888, pp. 152, 153. For effects of these doctrines on the Jews, see Milman, History of the Jews, vol. iii, p. 179; also Wellhausen, History of Israel, London, 1885, p. 546; also Beugnot, Les Juifs d'Occident, Paris, 1824, B, p. 114 (on driving Jews out of other industries than money-lending).

* For Gerson's argument favoring a reasonable rate of interest, see Coquelin and Guil-

Another mode of obtaining relief was tried. Subtle theologians devised evasions of various sorts. Two among these inventions of the schoolmen obtained much notoriety.

The first was the doctrine of "*damnum emergens*": if a man, in order to loan money, was obliged to withdraw it from profitable business, and so suffer loss, it was claimed that he might demand of the borrower compensation for such loss. Equally cogent was the doctrine of "*lucrum cessans*": if a man, in order to loan money, was obliged to diminish his income from productive enterprises, it was claimed that he might receive in return, in addition to his money, an amount exactly equal to this diminution in his income.

But such evasions were looked upon with little favor by the great body of theologians, and the name of St. Thomas Aquinas was cited against them.

Opposition on scriptural grounds to the taking of interest was not confined to the older Church. Protestantism was led by Luther and several of his associates into the same line of thought and practice. Said Luther: "To exchange anything with any one and gain by the exchange is not to do a charity, but to steal. Every usurer is a thief worthy of the gibbet. I call those usurers who lend money at five or six per cent." But it is only just to say that at a later period Luther took a much more moderate view. Melanchthon, defining usury as any interest whatever, condemned it again and again; and the Goldberg Catechism of 1558, for which he wrote a preface and recommendation, declares every person taking interest for money a thief; from generation to generation this doctrine was upheld by the more eminent divines of the Lutheran Church in all parts of Germany.

The English reformers showed the same hostility to interest-bearing loans. Under Henry VIII the law of Henry VII against taking interest had been modified for the better; but the revival of religious feeling under Edward VI caused in 1552 the passage

laumin, Dictionnaire, article Intérêt. For the renewed opposition to the taking of interest in England, see Craik, History of British Commerce, chap. vi. The statute cited is 3 Henry VII, chap. vi. It is found in Gibson's Corpus Juris Eccles. Anglic., p. 1071. For the adverse decree of Leo X, see Liégois, p. 76. See also Lecky, Rationalism, vol. ii. For the dragging out of the usurer's body at Piacenza, see Burckhardt, The Renaissance in Italy, London, 1878, vol. ii, p. 339. For public opinion of similar strength on this subject in England, see Cunningham, p. 239; also Pike, History of Crime in England, vol. i, pp. 127, 193. For good general observations on the same, see Stephen, History of Criminal Law in England, London, 1883, vol. iii, pp. 195–197. For usury laws in Castile and Aragon, see Bédarride, pp. 191, 192. For exceedingly valuable details as to the attitude of the mediæval Church, see Léopold Delisle, Études sur la Classe Agricole en Normandie au Moyen Âge, Evreux, 1851, pp. 200 *et seq.*, also p. 468. For penalties in France, see Matthew Paris, Chronica Majora, in Master of the Rolls series, especially vol. iii, pp. 191, 192.

of the "Bill of Usury." In this it is said, "Forasmuch as usury is by the word of God utterly prohibited, as a vice most odious and detestable, as in divers places of the Holy Scriptures it is evident to be seen, which thing by no godly teachings and persuasions can sink into the hearts of divers greedy, uncharitable, and covetous persons of this realm, nor yet, by any terrible threatenings of God's wrath and vengeance," etc., it is enacted that whosoever shall thereafter lend money "for any manner of usury, increase, lucre, gain, or interest, to be had, received, or hoped for," shall forfeit principal and interest, and suffer imprisonment and fine at the king's pleasure.*

But, most fortunately, it happened that Calvin, though at times stumbling over the usual texts against the usance of money, turned finally in the right direction. He cut through the metaphysical arguments of Aristotle, and characterized the mass of subtleties devised to evade the Scriptures as "a childish game with God." In place of these subtleties, there was developed among Protestants a serviceable fiction—the statement that usury means *illegal or oppressive interest*. Under the action of this fiction, commerce and trade revived rapidly in Protestant countries, though with occasional checks from exact interpreters of Scripture. At the same period in France, the great Protestant jurist, Dumoulin, brought all his legal learning and skill in casuistry to bear on the same side. A certain ferret-like acuteness and litheness seem to have enabled him to hunt down the opponents of usance through the most tortuous arguments of scholasticism.

In England the struggle went on with varying fortune; statesmen on one side, and theologians on the other. We have seen how under Henry VIII interest was allowed at a fixed rate, and how the development of English Protestantism having at first strengthened the old theological view, there was, under Edward VI, a temporarily successful attempt to forbid usance by law. The Puritans, dwelling on Old Testament texts, continued for a considerable time especially hostile to the taking of any interest. Henry Smith, a noted preacher, thundered from the pulpit of St. Clement Danes in London against "the evasions of Scripture" which permitted men to loan money on interest at all. In answer to the contention that only "biting" usury was oppress-

* For Luther's views see his sermon, Von dem Wucher, Wittenberg, 1519, also the Tischreden, cited in Coquelin and Guillaumin, article Intérêt. For the later more moderate views of Luther, Melanchthon, and Zwingli, making a compromise with the needs of society, see Böhm-Bawerk, p. 27, citing Wiskemann. For Melanchthon and a long line of the most eminent Lutheran divines who have denounced the taking of interest, see Die Wucherfrage, St. Louis, 1869, pp. 94 *et seq.* For the law against usury under Edward VI, see Cobbett's Parliamentary History, vol. i, p. 596; see also Craik, History of British Commerce, chap. vi.

ive, Wilson, a noted upholder of the strict theological view in political economy, declared: "There is difference in deed between the bite of a dogge and the bite of a flea, and yet, though the flea doth lesse harm, yet the flea doth bite after hir kinde, yea, and draweth blood, too. But what a world this is, that men will make sin to be but a flea-bite, when they see God's word directly against them."

The same view found strong upholders among contemporary English Catholics. One of the most eminent of these, Nicholas Sanders, revived very vigorously the use of an old scholastic argument. He insisted that "man can not sell time," that time is not a human possession, but something which is given by God alone: he declared, "Time was not of your gift to your neighbor, but of God's gift to you both."

In the Parliament of the period, we find strong assertions of the old idea, with constant reference to Scripture and the fathers. In one debate, Wilson cited from Ezekiel and other prophets and attributed to St. Augustine the doctrine that "to take but a cup of wine is usury and damnable." Fleetwood recalled the law of King Edward the Confessor, which submitted usurers to the ordeal.

But arguments of this sort had little influence upon Elizabeth and her statesmen. They re-established the practice of the taking of interest under restrictions, and this, in various forms, has remained in England ever since Most notable in this phase of the evolution of scientific doctrine in political economy at that period is the emergence from the political chaos of a recognized difference between *usury* and *interest*. Between these two words, which had so long been synonymous, a distinction now appears: the former being construed to indicate oppressive interest, and the latter just rates for the use of money. This idea gradually sank into the popular mind of Protestant countries, and the scriptural texts no longer presented any difficulty to the people at large, since there grew up a general belief that the word "usury," as used in Scripture, had always meant exorbitant interest. Still, that the old Aristotelian quibble had not been entirely forgotten, is clearly seen by various passages in Shakespeare's Merchant of Venice. But this line of reasoning seems to have received its quietus from Lord Bacon. He did not indeed develop a strong and connected argument on the subject, but he burst the bonds of Aristotle, and based usance for money upon natural laws. How powerful the new current of thought was, is seen from the fact that James I, of all monarchs the most fettered by scholasticism and theology, sanctioned a statute dealing with interest for money as absolutely necessary. Yet, even after this, the old idea asserted itself, for the bishops utterly refused to agree

to the law allowing interest until a proviso was inserted that "nothing in this law contained shall be construed or expounded to allow the practice of usury in point of religion or conscience." The old view cropped out from time to time in various public declarations. Among these was the book of John Blaxton, an English clergyman, who in 1634 published his Usury Condemned. In this, he defines usury as the taking of any interest whatever for money, citing in support of this view six archbishops and bishops and over thirty doctors of divinity in the Anglican Church—some of their utterances being very violent and all of them running their roots down into texts of Scripture. Typical among these is a sermon of Bishop Sands, in which he declares, regarding the habit of taking interest: "This canker that hath corrupted all England; we shall doe God and our country true service by taking away this evill; represse it by law, else the heavy hand of God hangeth over us and will strike us."

But departures from the strict scriptural doctrines regarding interest soon became frequent in Protestant countries. They appear to have been first followed up with vigor in Holland. Various theologians in the Dutch Church attempted to assert the scriptural view by excluding bankers from the holy communion, but the commercial vigor of the republic was too strong: Salmasius led on the forces of right reasoning brilliantly and by the middle of the seventeenth century the question was settled rightly in that country. This work was aided, indeed, by a far greater man—Hugo Grotius; but here was shown the power of an established dogma. Great as Grotius was—and though it may well be held that his book on War and Peace has wrought more benefit to humanity than any other attributed to human authorship—he was, in the matter of usance for money, too much entangled in theological reasoning to do justice to his cause or to himself. He declared the prohibition of interest to be scriptural, but resisted the doctrine of Aristotle, and allowed usance on certain natural and practical grounds.

In Germany the struggle lasted longer. Of some little significance, perhaps, is the demand of Adam Contzen, in 1629, that lenders at interest should be punished as thieves; but by the end of the seventeenth century Puffendorf and Leibnitz had gained the victory.

Protestantism, open as it was to the currents of modern thought, could not long continue under the dominion of ideas unfavorable to economic development, and perhaps the most remarkable example of this was presented early in the eighteenth century by no less strict a theologian than Cotton Mather. In his Magnalia he argues against the whole theological view with a boldness, acute-

ness, and good sense which cause us to wonder that this can be the same man who was so infatuated regarding witchcraft. After an argument so conclusive as his, there could have been little left of the old anti-economic doctrine in New England.*

But while the retreat in the Protestant Church was henceforth easy, in the Catholic Church it was far more difficult. Infallible popes and councils, saints, fathers, and doctors, had so constantly declared the taking of any interest at all to be contrary to Scripture, that the more exact though less fortunate interpretation of the sacred text relating to interest continued in Catholic countries. When it was attempted in France in the seventeenth century to argue that usury "means oppressive interest," the Theological Faculty of the Sorbonne declared that usury is the taking of any interest at all, no matter how little, and the eighteenth chapter of Ezekiel was cited to clinch this argument.

Another attempt to ease the burden of industry and commerce was made by declaring that "usury means interest demanded not as a matter of favor, but as a matter of right." This, too, was solemnly condemned by Pope Innocent XI.

Again, an attempt was made to find a way out of the difficulty by declaring that "usury is interest greater than the law allows." This, too, was condemned, and so also was the declaration that "usury is interest on loans not for a fixed time."

Still, the forces of right reason pressed on, and, among them, in the seventeenth century, in France, was Richard Simon. He attempted to gloss over the declarations of Scripture against usance in an elaborate treatise, but was immediately confronted by Bossuet, the greatest of French bishops, one of the keenest and strongest of thinkers. Just as Bossuet had mingled Script-

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* For Calvin's views, see his letter published in the appendix to Pearson's Theories on Usury. His position is well stated in Böhm-Bawerk, pp. 28 *et seq.*, where citations are given. See also Economic Tracts, No. IV, New York, 1881, pp. 34, 35; and for some serviceable Protestant fictions, see Cunningham, Christian Opinion on Usury, pp. 60, 61. For Dumoulin (Molinæus), see Böhm-Bawerk, as above, pp. 29 *et seq.* For debates on usury in British Parliament in Elizabeth's time, see Cobbett, Parliamentary History, vol. i, pp. 756 *et seq.* The passage in Shakespeare is in the Merchant of Venice, Act I, Scene III: "If thou wilt lend this money, lend it not as to thy friend; for when did friendship take a breed for barren metal from his friend?" For the right direction taken by Lord Bacon, see Neumann, Geschichte des Wuchers in Deutschland, Halle, 1865, pp. 497, 498. For Grotius, see the De Jure Belli ac Pacis, lib. ii, cap. xii; and for Salmasius and others mentioned, see Böhm-Bawerk, pp. 34 *et seq.*, also Lecky, vol. ii, p. 256. For the saving clause inserted by the bishops in the statute of James I, see the Corpus Juris Eccles. Anglic., p. 1071; also Murray, History of Usury, Philadelphia, 1866, p. 49. For Blaxton, see his English Usurer; or, Usury Condemned, by John Blaxton, Preacher of God's Word, London, 1634. Blaxton gives some of Calvin's earlier utterances against interest. For Bishop Sands's sermon, see p. 11. For Cotton Mather's argument, see the Magnalia, London, 1702, pp. 51, 52.

ure with astronomy and opposed the Copernican theory, so now he mingled Scripture with political economy and denounced the lending of money at interest. He called attention to the fact that the Scriptures, the councils of the Church from the beginning, the popes, the fathers, had all interpreted the prohibition of "usury" to be a prohibition of any lending at interest; and he demonstrated this interpretation to be the true one. Simon was put to confusion and his book condemned.

There was but too much reason for Bossuet's interpretation. There stood the fact that the prohibition of one of the most simple and beneficial principles in political and economical science was affirmed, not only by the fathers, but by twenty-eight councils of the Church, six of them general councils, and by seventeen popes, to say nothing of innumerable doctors in theology and canon law. And these prohibitions by the Church had been accepted as of divine origin by all obedient sons of the Church in the Government of France. Such rulers as Charles the Bald in the ninth century, and St. Louis in the thirteenth, had riveted this idea into the civil law so firmly that it seemed impossible ever to detach it.*

As might well be expected, Italy was one of the countries in which the theological theory regarding usance was most generally asserted and assented to. Among the great number of Italian canonists who supported the theory, two deserve especial mention, as affording a contrast to the practical manner in which the commercial Italians met the question.

In the sixteenth century, very famous among canonists was the learned Benedictine, Vilagut. In 1589 he published at Venice his great work on usury, supporting with much learning and vigor the most extreme theological consequences of the old doctrine. He defines usury as the taking of anything beyond the original loan, and declares it mortal sin; he advocates the denial to usurers of Christian burial, confession, the sacraments, absolution, and connection with the universities; he declares that priests receiving offerings from usurers should refrain from exercising their ministry until the matter is passed upon by the bishop.

About the middle of the seventeenth century another ponder-

* For the declaration of the Sorbonne in the seventeenth century against any taking of interest, see Lecky, Rationalism, vol. ii, p. 248, note. For the special condemnation by Innocent XI, see Damnatæ Theses, Pavia, 1715, pp. 112–114. For consideration of various ways of escaping the difficulty regarding interest, see Lecky, Rationalism, vol. ii, pp. 249, 250. For Bossuet's strong declaration against taking interest, see Œuvres de Bossuet, edition of 1845, vol. xi, p. 330, and edition of 1846, vol. ix, p. 49 *et seq.* For the number of councils and popes who condemned usury, see Lecky, Rationalism, vol. ii, p. 255, note, citing Concina.

ous folio was published in Venice upon the same subject and with the same title, by Onorato Leotardo. So far from showing any signs of yielding, he is even more extreme than Vilagut had been, and quotes with approval the old declaration that lenders of money at interest are not only robbers but murderers.

So far as we can learn, no real opposition was made in either century to this theory, as a theory; as to *practice*, it was different. The Italian bankers and traders did not answer the theological argument; they simply overrode it. Nowhere was commerce carried on in more complete defiance of this and other theological theories hampering trade than in the very city where these great treatises were published. The sin of usury, like the sin of commerce with the Mohammedans, seems to have been settled for by the Venetian merchants on their death-beds, and greatly to the advantage of the magnificent churches and ecclesiastical adornments of the city.

But in the eighteenth century there came a change. The first effective onset of political scientists against the theological opposition in southern Europe was made in Italy; the most noted leaders in the attack being Galiani and Maffei.

Here and there feeble efforts were made to meet them, but it was felt more and more by thinking churchmen that entirely different tactics must be adopted.

About the same time came an attack in France, and, though its results were less immediate at home, they were much more effective abroad. In 1748 appeared Montesquieu's Spirit of the Laws. In this famous book were concentrated twenty years of study and thought by a great thinker on the interests of the world about him. In eighteen months it went through twenty-two editions; it was translated into every civilized language; and among the things on which Montesquieu brought his wit and wisdom to bear with especial force was the doctrine of the Church regarding interest on loans. In doing this he was obliged to use a caution in forms which seems strangely at variance with the boldness of his ideas. In view of the strictness of ecclesiastical control in France, he felt it safest to make his whole attack upon those theological and economic follies of Mohammedan countries which were similar to those which the theological spirit had fastened on France.*

By the middle of the eighteenth century the Church authorities at Rome clearly saw the necessity of a concession: the world would endure theological restriction no longer; a way of escape

* For Vilagut, see his Tractatus de Usuris, Venice, 1589, especially pp. 21, 25, and 399. For Leotardus, see his De Usuris, Venice, 1655, especially preface, pp. 6, 7 *et seq.* For the eighteenth century attack in Italy, see Böhm-Bawerk, pp. 48 *et seq.* For Montesquieu's view of interest on loans, see the Esprit des Lois.

must be found. It was seen even by the most devoted theologians that mere denunciations and use of theological arguments or scriptural texts against the scientific idea were futile.

To this feeling it was due that, even in the first years of the century, the Jesuit casuists had come to the rescue. With exquisite subtlety some of their acutest intellects devoted themseves to explaining away the utterances on this subject of saints, fathers, doctors, popes, and councils. These explanations were wonderfully ingenious, but many of the older churchmen continued to insist upon the orthodox view, and at last the Pope himself intervened. Fortunately for the world, the seat of St. Peter was then occupied by Benedict XIV, certainly one of the most gifted, morally and intellectually, in the whole line of Roman pontiffs: tolerant and sympathetic for the oppressed, he saw the necessity of taking up the question, and he grappled with it effectually. While severe against exorbitant usury, he rendered to Catholicism a service like that which Calvin had rendered to Protestantism, by quietly but vigorously cutting a way through the theological barrier. In 1745 he issued his encyclical, *Vix pervenit*, which declared that the doctrine of the Church remained consistent with itself; that usury is indeed a sin, and that it consists in *demanding any amount beyond the exact amount lent*, but that there are occasions when on special grounds the lender may obtain such additional sum.

What these "occasions" and "special grounds" might be, was left very vague; but this action was sufficient.

At the same time no new restrictions upon books advocating the taking of interest for money were imposed, and the Pope openly accepted the dedication of one of them.

Like the casuistry of Boscovich in using the Copernican theory for "convenience in argument," while acquiescing in its condemnation by the Church authorities, this encyclical of Pope Benedict broke the spell. Turgot, Quesnay, Adam Smith, Hume, Bentham, and their disciples pressed on, and science won for mankind another great victory.*

* For Quesnay, see his Observations sur l'Intérêt de l'Argent, in his Œuvres, Frankfort and Paris, 1888, pp. 399 *et seq.* For Turgot, see the Collection des Économistes, Paris, 1844, vols. iii and iv; also, Blanqui, Histoire de l'Économie Politique, English translation, p. 373. For an excellent though brief summary of the efforts of the Jesuits to explain away the old action of the Church, see Lecky, vol. ii, pp. 256, 257. For the action of Benedict XIV, see Reusch, Der Index der Verbotener Bücher, Bonn, 1885, vol. ii, pp. 847, 848. For a comical picture of the "quagmire" into which the hierarchy brought itself in the squaring of its practice with its theory, see Döllinger as above, pp. 227, 228. For cunningly vague statements of the action of Benedict XIV, see Mastrofini, Sur l'Usure, French translation, Lyons, 1834, pp. 125 and 255. The abbé, as will be seen, has not the slightest hesitation in telling an untruth, in order to preserve the consistency of papal action in the matter of usury; e. g., pp. 93, 94, 96, and elsewhere.

Yet in this case, as in others, insurrections against the sway of scientific truth appeared among some overzealous religionists. When the Sorbonne, having retreated from its old position, armed itself with new casuistries against those who held to its earlier decisions, sundry provincial doctors in theology protested indignantly, making the old citations from the Scriptures, fathers, saints, doctors, popes, councils, and canonists. Again the Roman court intervened. In 1830 the Inquisition at Rome, with the approval of Pius VIII, though still declining to commit itself on the *doctrine* involved, decreed that, as to *practice*, confessors should no longer disturb lenders of money at legal interest.

But even this did not quiet the more conscientious theologians. The old weapons were again furbished and hurled by the Abbé Laborde, Vicar of the Metropolitan Archdiocese of Auch, and by the Abbé Dennavit, Professor of Theology at Lyons. Good Abbé Dennavit declared that he refused absolution to those who took interest and to priests who pretend that the sanction of the civil law is sufficient.

But the "wisdom of the serpent" was again brought into requisition, and early in the decade between 1830 and 1840 the Abbate Mastrofini issued a work on usury, which, he declared on its title-page, demonstrated that "moderate usury is not contrary to Holy Scripture, or natural law, or the decisions of the Church." Nothing can be more comical than the suppressions of truth, evasions of facts, jugglery with phrases, and perversions of history, to which the good abbate is forced to resort throughout his book in order to prove that the Church has made no mistake. In the face of scores of explicit deliverances and decrees of fathers, doctors, popes, and councils, against the taking of any interest whatever for money, he coolly pretended that what they had declared against was *exorbitant* interest. He made a merit of the action of the Church, and showed that its course had been a blessing to humanity. But his masterpiece is in dealing with the edicts of Clement V and Benedict XIV. As to the first, it will be remembered that Clement, in accord with the Council of Vienne, had declared that "any one who shall pertinaciously presume to affirm that the taking of interest for money is not a sin, we decree him to be a heretic, fit for punishment," and we have seen that Benedict XIV did not at all deviate from the doctrines of his predecessors. Yet Mastrofini is equal to his task, and brings out, as the conclusion of his book, the statement put upon his title-page that what the Church condemns is only exorbitant interest.

This work was sanctioned by various high ecclesiastical dignitaries, and served its purpose, for it covered the retreat of the Church.

In 1873 appeared a book published under authority from the

Holy See, allowing the faithful to take moderate interest under condition that any future decisions of the Pope should be implicitly obeyed. Social science as applied to political economy had gained a victory final and complete. The Torlonia family at Rome to-day, with its palaces, chapels, intermarriages, affiliations, and papal favor—all won by lending money at interest and by devotion to the Roman See—is but one out of many growths of its kind on ramparts long since surrendered and deserted.*

The dealings of theology with public economy were by no means confined to the taking of interest for money. It would be interesting to note the restrictions placed upon commerce by the Church prohibition of commercial intercourse with infidels, against which the Republic of Venice fought a good fight; to note how, by a most curious perversion of Scripture in the Greek Church, many of the peasantry of Russia were prevented from raising and eating potatoes; how, in Scotland, at the beginning of this century, the use of fanning-mills for winnowing grain was widely denounced as contrary to the text, "The wind bloweth where it listeth," etc., as leaguing with Satan, who is "prince of the powers of the air," and therefore as sufficient cause for excommunication from the Scotch Church. Instructive it would be also to note how the introduction of railways was declared by an archbishop of the French Church to be an evidence of the divine displeasure against country innkeepers who set meat before their guests on fast-days, and who were now punished by seeing travelers carried by their doors; how railways and telegraphs were denounced from a few noted pulpits as heralds of Antichrist; and how in Protestant England the curate of Rotherhithe, at the breaking in of the Thames Tunnel, so destructive to life and property, declared it from his pulpit a just judgment upon the presumptuous aspirations of mortal man.

The same tendency is seen in the opposition of conscientious men to the taking of the census in Sweden and the United States,

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* For the decree forbidding confessors to trouble lenders of money at legal interest, see Addis and Arnold, Catholic Dictionary, as above; also Mastrofini, as above, in the appendix, where various other recent Roman decrees are given. As to the controversy generally, see Mastrofini; also La Replique des douze Docteurs, cited by Guillaumin and Coquelin; also Reusch, vol. ii, p. 850. As an example of Mastrofini's way of making black appear white, compare the Latin text of the decree on p. 97 with his statements regarding it; see also his cunning substitution of the new significance of the word usury for the old in various parts of his work. A good historical presentation of the general subject will be found in Roscher, Geschichte der National-Oeconomie in Deutschland, München, 1874, under articles Wucher and Zinsnehmen. For France, see especially Petit, Traité de l'Usure, Paris, 1840; and for Germany see Neumann, Geschichte des Wuchers in Deutschland, Halle, 1865. For the view of a modern leader of thought in this field, see Jeremy Bentham, Defense of Usury, Letter X.

on account of the terms in which the numbering of Israel is spoken of in the Old Testament. Religious scruples on similar grounds have also been avowed against so beneficial a thing as life insurance.

Apparently unimportant as these manifestations are, they indicate a wide-spread tendency in the application of scriptural declarations to matters of social economy which has not yet ceased, though it is fast fading away.*

Worthy of especial study, too, would be the evolution of the better modern methods of raising and bettering the condition of the poor; the evolution, especially, of the idea that men are to be helped to help themselves, in opposition to the old theories of indiscriminate giving, which, taking root in some of the most beautiful utterances of our sacred books, grew in the warm atmosphere of mediæval devotion into great systems for the pauperizing of the laboring classes. Here, too, scientific modes of thought in social science have given a new and nobler fruitage to the whole growth of Christian benevolence.†

Prof. Riley's paper in the American Association, on the Use of Micro-organisms as Insecticides, has a tone of warning. While much may be anticipated from the new form of application, it is important to avoid exaggerated statements. There is a tendency in the public mind to take as proved what has not yet passed beyond the stage of possibility. In theory, the idea of doing battle against injurious insects by means of invisible germs is very tempting; but it has unfortunately been most dwelt upon by those who were essentially closet workers, and had but a faint realization of the practical necessities of the case.

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* For various interdicts laid on commerce by the Church, see Heyd, Histoire du Commerce du Levant au Moyen-Age, Leipsic, 1886, vol. ii, *passim*. For the injury done to commerce by prohibition of intercourse with the infidel, see Lindsay, History of Merchant Shipping, London, 1874, vol. ii. For superstitions regarding the introduction of the potato, and the name "devil's root" given it, see Hellwald, Culturgeschichte, vol. ii, p. 476; also Haxthausen, La Russie. For opposition to winnowing machines, see Burton, History of Scotland, vol. viii, p. 511; also Lecky, Eighteenth Century, vol. ii, p. 83; also Mause Headrigg's views in Scott's Old Mortality, chap. vii. For the case of a person debarred from the communion for "raising the devil's wind" with a winnowing machine, see Works of Sir J. Y. Simpson, vol. ii. Those doubting the authority or motives of Simpson may be reminded that he was to the day of his death one of the strictest adherents to Scotch orthodoxy. As to the curate of Rotherhithe, see Journal of Sir I. Brunel for May 20, 1827, in Life of I. K. Brunel, p. 30. As to the conclusions drawn from the numbering of Israel, see Michaelis, Commentaries on the Laws of Moses, 1874, vol. ii, p. 3. The author of this work himself witnessed the reluctance of a very conscientious man to answer the questions of a census marshal, Mr. Lewis Hawley, of Syracuse, N. Y.; and this reluctance was based upon the reasons assigned in 2 Samuel, xxiv, 1, and 1 Chronicles, xxi, 1, for the numbering of the children of Israel.

† Among the vast number of authorities regarding the evolution of better methods in dealing with pauperism, I would call attention to a recent work which is especially suggestive—Behrends, Christianity and Socialism, New York, 1886.

REMARKABLE BOWLDERS.

By DAVID A. WELLS.

THE calling of attention, in The Popular Science Monthly for June, 1890, to the evidences of glacial action in southeastern Connecticut afforded by the number and great size of the bowlders in that section of the country, with accompanying illustrations from photographs, has been instrumental in creating no little popular interest on the subject, and in bringing to the attention of the public many other interesting examples of like glacial phenomena that have hitherto almost escaped notice.

Accepting reported measurements, the largest erratic block, or bowlder, as yet recognized in the United States, and probably in the world, is in the town of Madison, N. H., and, according to Prof. Crosby, of the Boston Institute of Technology, has the following maximum dimensions: Length, 83 feet; width, in excess of 45 feet; height, 30 to 37 feet; contents, 90,000 cubic feet; and probable weight, 15,300,000 pounds, or 7,650 tons.

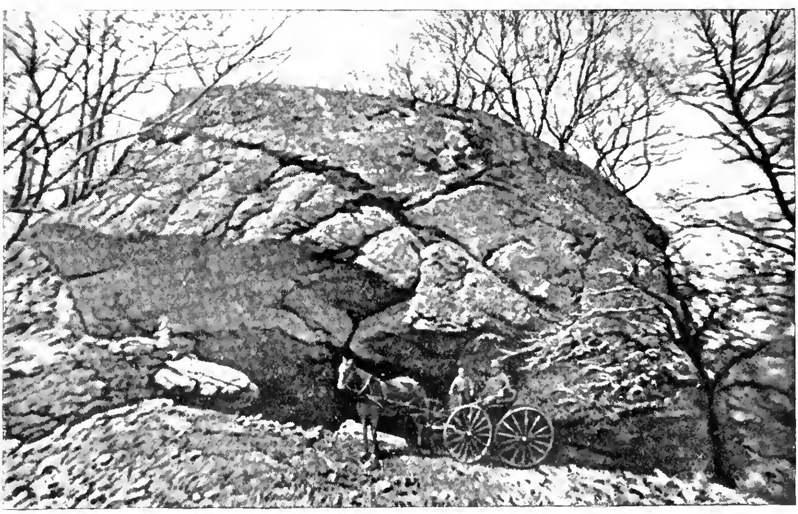


Fig. 1.

Next to this in size is undoubtedly the great rock in the town of Montville, New London County, Connecticut, generally known by its Indian designation as "Sheegan," and also as "Mohegan" (Fig. 1). In the opinion of some, this rock is an isolated granite protuberance, and not a true "erratic" or bowlder; but recent examinations have seemed to completely negative the first supposition. Its approximate maximum dimensions are: Length, 75 feet; width, 58 feet; height, 60 feet; contents, 70,000 cubic feet; weight,

6,000 tons. If allowance be made for an immense fragment which has fallen from its northeast side, the dimensions and cubic contents of "Sheegan" would approximate more closely to those of the Madison bowlder. One point that goes far toward substantiating the claim on behalf of the "Sheegan" rock that it is a true bowlder, is the number of undoubted bowlders of an immense size and of the same granite which exist in comparative proximity. One, about a mile northwesterly, measures 21 feet high, 25 feet long, and 25 feet thick. Another, some three miles southeasterly, and but a short distance west of the Waterford station, on the New London and Northern Railroad (Fig. 2), and whose existence has

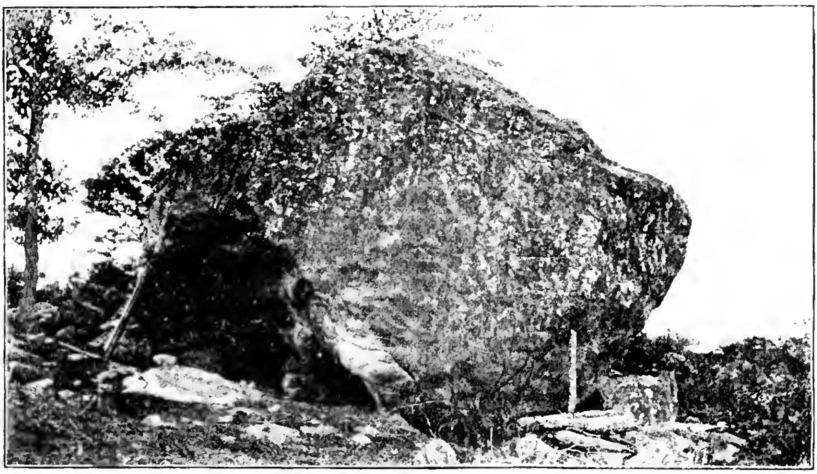


FIG. 2.

heretofore been only locally recognized, has almost the same dimensions; with the added peculiarity of a cavity, or rather tunnel, at its base, some five feet or more at the entrance, and extending with diminishing dimensions completely through the whole mass of the rock, which is about 25 feet in thickness. This cavity, which is somewhat imperfectly shown in the accompanying picture, is of such capacity that it has been fitted up with a cooking-stove, and has served a tramp family as a summer residence.

But one of the most curious and instructive examples of the disruptive and motor power of moving ice during the Glacial period to which attention has ever been called, occurs on the line of the New London and New Haven or "Shore Line" Railroad, about midway between Guilford and Leet's Island stations, and about a mile and a half from either place. Here, on the top of a narrow ledge of rock, which might almost be characterized as a pinnacle, rising (nearly perpendicularly from a salt marsh, or swamp, on one side) to a height of about 60 feet, rests a rectangular, sar-

cophagus-looking block, 16 feet long, tapering from 7 feet 10 inches in width at one end to 5 feet 10 inches at the other, with an average thickness of 5 feet, and an approximative weight of about 60 tons (see Fig. 3).

The peculiarities of this block, which invest it with unusual

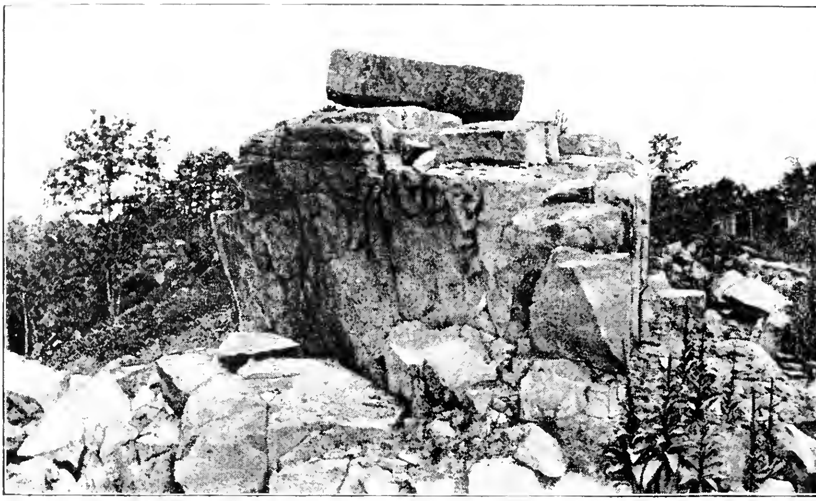


Fig. 3.

interest, are: First, its apparent artificiality; second, the surface on which it rests is so narrow, smooth, and rounded, that, were it not for the blocking of a flat slab of rock (shown in Fig. 4), apparently artificially inserted underneath in exactly the proper

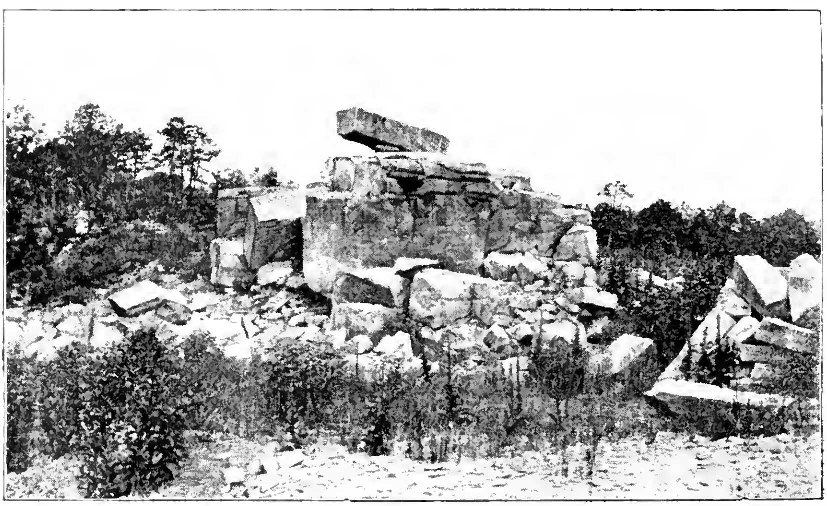


Fig. 4.

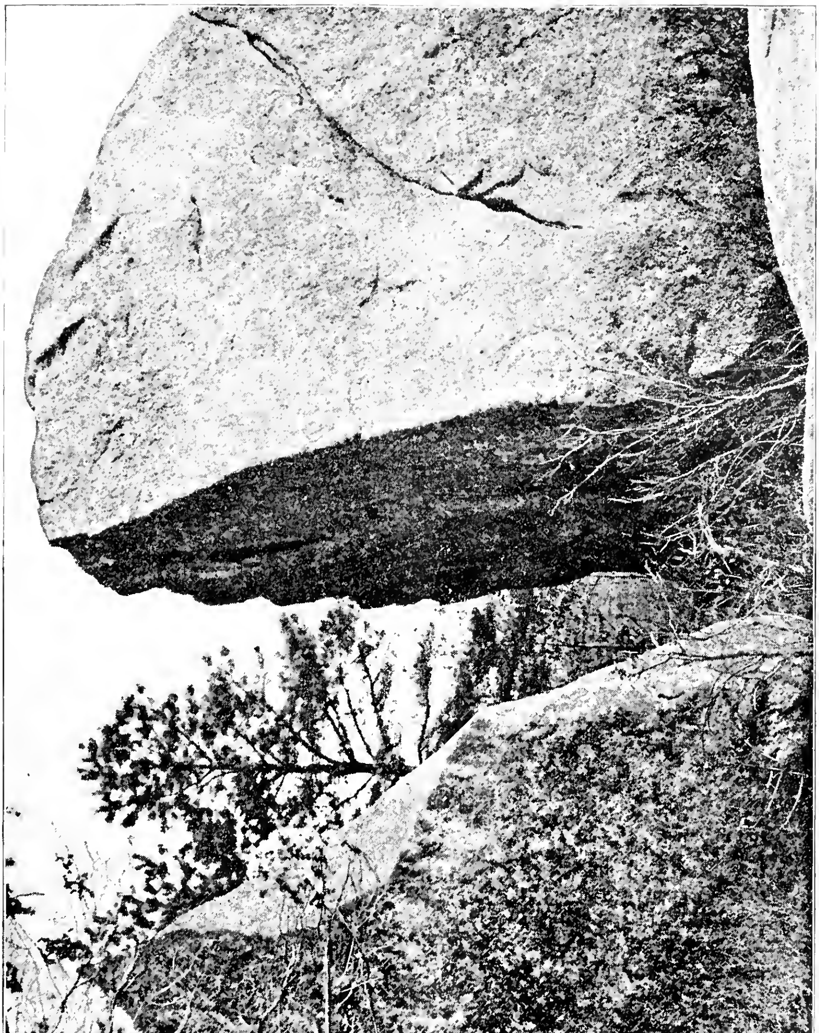


Fig. 5.

place, the block when released—i. e., by the melting of the ice—from the power that transported and placed it must have slid down and found a resting-place at the bottom of what is now a contiguous salt marsh; and, third, the circumstance that all the edges and angles of the block are as sharp and free from abrasion—which last is also true of its entire surface—as if it were but recently lifted from its original bed by the most modern and careful system of quarrying. It could not obviously, therefore, in its process of transportation have been rolled or tumbled about to any great extent; which conclusion in turn suggests that its movement after the first displacement was a lifting up to its present elevation, and that it was not subsequently transported to any great distance laterally. The extension of the ledge on which this great block rests having been largely broken up and removed through its use as a quarry, what might have been evidence confirmatory of this effect is now no longer obtainable. That it would have been perfectly practicable, with the requisite labor and machinery and large expenditure, to have quarried this block, and then have lifted it up and blocked it in its present position, is not to be denied; but the idea that any such thing has been done, and for no practical purpose, is perfectly untenable. The surrounding country is very thinly populated, and the rock was in position long before any quarry (for the obtaining of rough stone for railroad construction) was worked in any immediate vicinity.

To travelers on the New London and New Haven Railroad this testimonial of the forces operative in a former geological age, by reason of its close proximity to the track, is clearly discernible on the right-hand side going west and the left-hand going east, and constitutes a most striking and picturesque object. Its obvious novelty, which has thus far undoubtedly saved it from destruction or displacement at the hands of workmen and vandals, may, it is to be hoped, continue to constitute its protection in the future, although as an object of attraction and interest to tourists and scientific men it is eminently worthy of care by the managers of the railroad company.

Figs. 5 and 6 are photographic reproductions of a huge bowlder, curiously disrupted on the land of Mr. Edward Atkinson, at Mattapoisett, on Buzzard's Bay, Mass., and having the following dimensions: Maximum height, 42 feet; measurement through the middle of the passage between the two fragments, from one side to the other in a straight line, 36 feet; average width of the crack between the two fragments at the level of the ground, 3½ feet; present surface area of the detached fragment, which has in part been quarried away, 462 feet.

To the trained geologist, the foregoing and all similar accounts

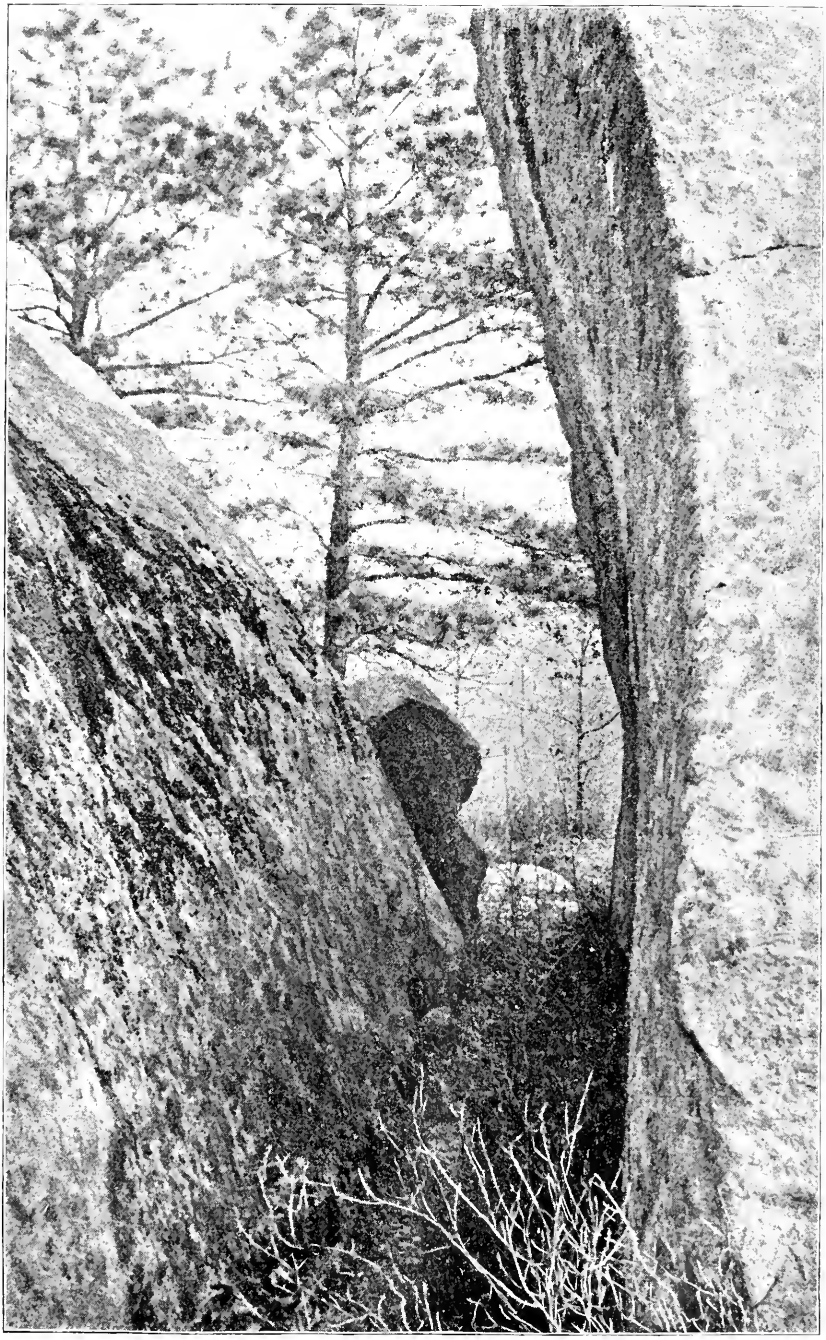


FIG. 6.

and representations of bowlders possess but little interest other than what pertains to peculiarities of size, shape, and location; while the agencies mainly concerned in the formation, movement, and distribution of the bowlder, as well as of the ordinary pebble, which is a miniature bowlder, have long ceased to be matters of controversy. With those not versed, however, in geological evidence and reasoning, the case is far different. To most of such, the attributing of the phenomena under consideration to the motor power of ice seems so fanciful and unnatural that the agency of the Indian (as has come within the experience of the writer) has appeared more reasonable. But if any one thus doubting will but acquaint himself with the present condition of Greenland, where we have a continental area covered with a sheet of ice of immense thickness—a mile or more, doubtless, in many places—continually accumulating through almost constant atmospheric precipitations, and moving, through the weight and pressure of such increments of snow and ice, with almost irresistible force from the center of such continent to its sea or coast line, and then in imagination transfer and reproduce such conditions (which are undoubted actualities) over the whole of the northern United States and Canada, he will be abundantly satisfied that the most striking of bowlder phenomena constitute but a very small measure of the forces that were concerned in their production and were concurrently exerted to modify the earth's surface—even to the extent of removing mountains.

It will also widen the sphere of interest in this subject to refer to the humbler but at the same time most instructive memorials of the Glacial period, which are, as it were, associated with the bowlders, and help to conceal the barrenness and desolation of the "drift"; namely, the pretty flowering plants like the "dandelion" and the "trailing arbutus," and others, which are believed to have come down in the Glacial period from their natural habitat in the far north to our present temperate zone, and to have remained, after the disappearance of the ice, with the bowlders as if to keep them company. Recent explorers of Greenland tell us that wherever in little sheltered nooks upon its dreary coast the ice and frost relax sufficiently in the brief summer to admit of any vegetation, these plants grow and flower most luxuriantly, while in their foreign homes they seem, as every one knows, to choose those times and temperatures for blooming and fruition—i. e., in the early spring—which are most in accordance with the conditions of their origin and primal existence; thus apparently reasserting their *feræ naturæ* as did the old vikings when associated with the more delicate types of southern latitudes.

TAIL-LIKE FORMATIONS IN MEN.

AFTER THE RESEARCHES OF DR. BARTELS, PROF. ECKER, DR. MOHNIKE, DR. ORNSTEIN, AND OTHERS.

TRADITIONS of tailed men are very old and wide-spread. Tailed races are told of in many countries, whose home is, however, usually placed in some little-known region; and the stories of individuals who had tails can hardly be counted. A number of legends on the subject have been collected by Mr. S. Baring-Gould, and published in his Curious Myths of the Middle Ages. This author himself was brought up in the belief that all Cornishmen had tails, and was not undeceived till a good Cornish bookseller, with whom he formed a warm friendship, assured him that this was not the case; after which he satisfied himself that the man had sat his tail off; and his nurse informed him that that was what happened to men of sedentary habits.

Certain men of Kent were said to have had tails inflicted upon them in punishment for their insults to St. Thomas à Becket. The story runs that when the saint came to Stroud on the Medway, the inhabitants of the place, being eager to show some mark of contumely to him in his disgrace, did not scruple to cut off the tail of the horse on which he was riding; and for this, according to Polydor Vergil, "it so happened, by the will of God, that all the offspring born from the men who had done this thing were born with tails like brute animals. But this mark of infamy, which formerly was everywhere notorious, has disappeared with the extinction of the race whose fathers perpetrated the deed." The story seems to have been applied, with variations, to other Englishmen, now here, now there, so that John Bale complained, in the time of Edward VI, "that an Englyshman now can not travayle in another land by way of marchandyse or any other honest occupyinge, but it is most contumeliously thrown in his tethe that all Englyshmen have tails."

A Polish writer tells of a witch who transformed a bridal company, stepping over a girdle of human skin which she had laid in the doorway, into wolves. She afterward, by throwing dresses of fur over them, gave them their human forms; but the bridegroom's dress was not long enough to cover his tail, and he kept it; whence it became hereditary in his family. John Struys, a Dutch traveler, who visited Formosa in the seventeenth century, relates that a member of his party got separated from the rest and was mangled and killed by a wild man, who was afterward caught and tied up for execution, when, says the traveler, "I beheld what I had never thought to see. He had a tail more than a foot long, covered with red hair, and very like that of a cow. When he saw

the surprise that this discovery created among the European spectators, he informed us that his tail was the effect of climate, for that all the inhabitants of the southern side of the island, where they then were, were provided with like appendages." The cuneiform or Chaldean deluge tablet speaks of the gods, "with tails hidden," crouching down. A Culdee tombstone at Keills, in Argyleshire, Scotland, bears among its figures one of human form, sitting down, and sleeking with his left hand a tail that curls beneath his legs.

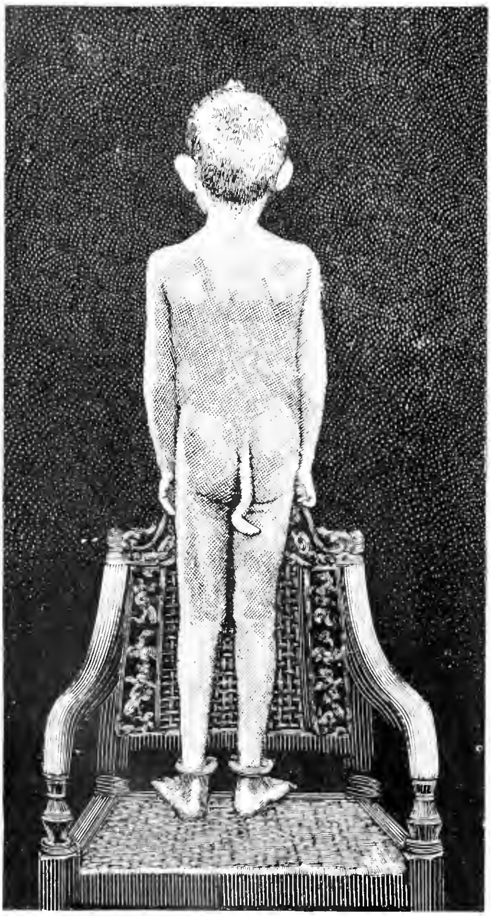


Fig. 1.—Tailed Moi Boy.

Various stories have been told of the tails of the Niam Niams of Central Africa, who have also been asserted to be cannibals. Their tails have been described as smooth and as hairy, as peculiar to the men, and as possessed by the men and women both. The most interesting and circumstantial account of this feature is given by Dr. Hubsch, of Constantinople, who examined a tailed negress. Her tail was about two inches long, and terminated in a point. The slave-dealer who owned her said that all the Niam Niams had tails, and that they were sometimes ten inches long. Dr. Hubsch also saw a man of the same race who had a tail an inch and a half long, covered with a few hairs; and he knew at Constantinople the son of a physician who was born with a tail an inch and a half long, and one of whose grandfathers had a like appendage. The phenomenon, he said, is regarded generally in the East as a sign of great brute force.

The newspapers, many years ago, had a story of a boy, who was born at Newcastle-on-Tyne, with a tail about an inch and

a half long, which, when sucking, he wagged as a token of pleasure.

Apparently well-authenticated instances of human tails are that of a Moi boy, twelve years old, who was found a few years ago in Cochin-China, and had a tail about a foot long—simply a mass of flesh—containing no bony frame (Fig. 1); and the case communicated to the Berlin Anthropological Society in July, 1890, by the Dutch resident at Ternate, of two natives of New Guinea, who had come on board his steamer in Geelvink Bay, in 1880—adult male Papuans, in good health and spirits, well shaped and muscular, who had coccygeal bones projecting four centimetres, or an inch and a half in length. Dr. O. W. Holmes says, in the Atlantic Monthly for June, 1890, that Dr. Priestley, of London, showed him, at the Medical Congress in Washington, a photograph of a boy who had "a very respectable tail."

In The Popular Science Monthly for October, 1884, an account was quoted from Mr. H. W. Eaton, of Louisville, Ky., of a female child that was born in that city with what appeared to be a rudimentary tail. It was visible as a "fleshy peduncular protuberance," about two inches and a quarter long, and measuring an inch and a quarter round the base, shaped like a pig's tail, but showing no sign of bone or cartilage, and was situated about an inch above the lower end of the spinal column. It had grown about a quarter of an inch in eight weeks.

The questions, whether there exists in the human body, in a rudimentary state, a real homologue of the tail of animals, and whether it may sometimes be developed into a member of somewhat similar outward form, have been much discussed by physiologists in recent years. Besides notes on the subject in anthropological, ethnographical, and geographical periodicals, four larger essays have been published upon it, viz.: Mohnike's pamphlet on Tailed Men (Münster, 1878); two papers by Prof. A. Ecker, in the Archiv für Anthropologie (vol. xii, 1879), and in the Archiv für Anatomie und Physiologie (1880, No. 6); and a paper by Dr. Max Bartels in the Archiv für Anthropologie (1880); all of which go into a searching consideration of the subject. The late German scientific journal Kosmos, reviewing these papers a few years years ago, deduced the following conclusions from the evidence then before the world:

The older anatomists treated the question in rather a matter-of-fact way. They regarded the prolongation of the human backbone beyond the *os sacrum*, by three, four, or five vertebræ, without much thought, as the analogous feature of the animal's tail, and called it the tail-bone (*os coccygis*). The phenomenon was not rare to them, nor did it seem wonderful that this part of the body could, contrariwise to its general rule, escape being grown over,

and project free like an animal's tail, or that it might occasionally be prolonged through additions to the number of vertebræ; for they had a deeper insight into the normal agreement of the fundamental scheme in the structure of man and the animals most nearly related to him than some of the physicians and anatomists of our own time seem to have.

But after the great "fall of man," as Ecker expressively calls it, or after man had tasted the fruit of the tree of knowledge which Darwin offered to him, we apparently did not dare to call the thing any more by its right name. We did not venture, according to Prof. His, to speak of the tail of the human embryo, although we could still speak without hesitation of its gill-arch. Man was ashamed, as Ecker has humorously characterized the prudery of the learned, only of his nearer, not of his more distant, cousins. The older anatomists and artists—we name here, as typical representatives of these, only Harvey, Meckel, and Goethe—found it natural that this taillet, instead of bending inward, as usual, toward the pelvis, and being buried in the muscular part, as though that were, of course, one of man's particular characteristics, should occasionally project outward and assume the form of an external tail. They did not regard it as surprising that a formation of this kind should sometimes appear; and they found in the persons who possessed such growths, not, like the men of the preceding age, the consequences of a bestial intercourse or of a fault of the mother; not even a monstrous formation in the common sense of the word, but rather evidence of the adaptability of Nature and of a common type marking all the higher animals. Thus Goethe wrote on the 12th of September, 1787, from Rome: "The tailed men are no wonder to me; but are, according to the description, something quite natural. There are much more wonderful things before our eyes which we do not regard, because they are not so nearly related to us."

The brief essay of Dr. O. Mohnike is based on the fact that all the forms of the backbone of man are related to his erect posture, and that the prolongation is turned inward in order to afford a support to the viscera, which is not needed in animals that go on all fours. He therefore believes that a prolongation of the coccyx outside of the periphery of the rump, analogous to the tail of an animal, would be incompatible with the typical human form, all the parts of which collectively point to the erect gait, and contradictory to it.

A similar inversion is indicated in the anthropoid apes, that have no external tail and sometimes go erect, and is believed by Hyrtl to be produced gradually in dogs and bears that are taught to dance on their hind legs. All this goes to show, if there were

any doubt on the subject, that the *os coccygis* of man is a real analogue of the animal's tail-root, while it also makes clear to us how the same has reached its special form. It is further confirmed by the fact that the inversion in which the coccyx takes part is not observed in the embryonal life of man nor in the earliest infancy, but first appears when the child begins to carry its body erect. The tail-like prolongation of the human vertebral column is evidently a rudimentary formation—an inheritance from the animal condition which, perhaps, persists simply because the inturned vertebra of the *os coccygis* has adapted itself to a new function, instead of becoming useless.

There is found in the human embryo, in the first stage of its embryonal life, just as in other vertebrates, a considerable and conformable tail-structure, which it is not hard to interpret according to biogenetical principles. The length of this taillet, in proportion to that of the rest of the body, is at first considerable. In embryos that have completed their third week the tail is, perhaps, about twice as long as the lower limbs. It is one of the pruderies that still live to vex us that some anatomists, Prof. His, of Leipsic, for example, object to calling this appendage a tail. But Prof. Ecker unequivocally upholds this designation, and in the Archiv für Anatomie und Physiologie (1880, No. 6, p. 442) formulates the following principles in elucidation of the matter:

Fig. 2.—Lower Part of an Embryo 15·5 mm. long, with Tail. From Ecker.

1. The name "tail" can only be applied to the part of the hinder end of the body projecting over the cloacum.

2. In embryos of the second class—that is, those which are from eight to fifteen millimetres long—the "tail" overtopping the cloacum appears as a free pointed projection upward and forward.

3. This tail consists of a vertebra-containing and a vertebra-free section, the latter of which contains only a *chorda* and a marrow-tube.

4. Only the latter section suffers a reduction, by the *chorda dorsalis* being mostly converted into a knot, while the rest disappears.

5. The vertebra-containing section persists for a longer time than the so-called coccygeal lump. The latter disappears gradually under the surface, chiefly in consequence of the gradually stronger curvature of the *os sacrum* and *os coccygis*, and partly of the more prominent development of the pelvic band and its musculature.

We should also distinguish two processes in the gradual disappearance of the embryonal tail of man: an atrophy of the tail-

point and a shrinking of the tail-root. The former process, the wasting of the hindermost section, takes place, according to the later researches of M. Braun in Dorpat, not only in the human embryo, but also in other vertebrates. "I find," says this naturalist, in his Researches in the Development-History of Parrots (Transactions of the Physico-Medical Society of Würzburg, new series, vol. xv), "in the embryos of swine, cats, sheep, rabbits, mice, and dogs, a long thread at the hinder end of the tail which is sharply distinguished by its tenuity from the rest of the member. The spinal or parted chorda end lies in it in the earlier stage; later it consists only of epidermis cells; and finally it disappears altogether. By this, proof is given that in mammalia as well as in birds the chorda, if I may use the expression, has been carried out too long, and no more vertebræ are formed around its hinder end. It is a striking fact that the long-tailed mammalia are also in this category."

According to Ecker, who confirms the other features of these observations, this attenuated prolongation, designated as a tail-thread, no longer appears in man;* the tail is reduced, much more, according to him, than appears in the sketch, into a conical form. The further wasting process has proceeded so far by the seventh week of the human embryonal life that a tail can no longer be fitly spoken of. Instead of it there is to be seen on the hinder end of the body only a roundish process, the coccygeal lump (Figs. 3 and 4), on which a few minute excrescences, perhaps rudiments of the atrophied invertebrate part of the tail, are visible. This coccygeal lump retains to the end of the third month the form of an acute isosceles triangle, the broad base of which rises in the region of the coccyx without a clear dividing line, while its point ends over the rectum. Two converging shallow furrows define the lateral boundaries between the coccygeal lump and the buttock, over the level of which it plainly rises. Beyond the rectum begins in the continuation of the median line of this triangle the suture, which in the male embryo extends as a plainly marked selvage over the perinæum. What is called the coccygeal lump in the human fœtus is a prominence so brought

Fig. 3.

Fig. 4.

Figs. 3 and 4.—Embryos in the Coccygeal-lump Period. Fig. 3, 4·1 cm. long; Fig. 4, 14·8 cm. long. From Ecker.

* In mammals Ecker sometimes found the tip of the tail-thread so sharp and horny that the name tail-spine seemed to be more appropriate, and he suggests that possibly the well-known tail-spine of the lion is nothing else than the persistent embryonal tail-thread.

forward that the point of the nearly straight-running coccyx is pushed against the skin and lifts it up. Inversion has at this time not yet taken place.

From the third to the fourth month the human fœtus receives its clothing of wool-hairs, which penetrate obliquely through the skin, and form hair-lines converging against the tips of the coccygeal lump, and represent there a vertebra. This vertebra—*vertex coccygeus*—constitutes in several cases observed and described by Ecker and other investigators (Fig. 5) an evident pencil of longer hairs, a real hair-taillet, such as Grecian art gave at the same point to fauns and satyrs. It has already been shown by Eschricht that the converging hair-tuft in the region of the coccyx is analogous to the similar arrangement of hairs on the tails of the mammalia. Chr. A. Voight has expressly noticed the same relation in his treatise on the direction of hairs on the human body (Denkschrift of the Vienna Academy, 1856). "The parts of the skin on which converging tufts are formed," he says, "are either places which were quite bare in the earlier periods of development, or they are spots that covered the prominent bones (or cartilages), the strongly growing parts, like the coccyx, the elbows, and the tip of the ear in animals, or every place toward which an extension of the skin was taking place or had taken place at the time of the development of the hair." This author remarks especially of the coccyx-tuft that, as the hairs become longer, they rise over the surface and form spiral-shaped hair-tufts, like the brushes on the tips of the tails of animals. There is thus again shown a plain original connection between the formation of the tail-shaped attachment and the coccygeal hair-tuft.

Fig. 5.—Coccygeal Hair-tuft. From Ecker.

There is usually found in the human fœtus, above the coccygeal vertebra, a hairless spot, the *glabella coccygea*, under which often appears later, and is even perceptible in persons of middle age, a depression of greater or less depth, the *foveola coccygea*, over the origin and significance of which many and often curious hypotheses have been set forth. It was described by Lawson Tait, in a paper read before the Anatomical and Physiological Section of the British Association in 1878. He had found from the examination of several hundred persons that only fifty-five per cent of them were without traces of the depression or "sacral dimple," while it was faintly marked in twenty-two per cent, and well marked in twenty-three per cent. But it seemed to become imperceptible

again after the thirtieth year of age. Mr. Tait believes that the hollow is associated with the embryonal process connected with the neural canal and its closure. He referred to the tailless cats of the Isle of Man, and tailless guinea-pigs which, like man, possess only an *os coccygis* with three pronged centra infolded in the skin; and thought that he might conclude from certain indications that some of these animals, and perhaps also the predecessors of man, may have lost the tail in consequence of a malformation, probably in man through the not rarely appearing *spina bifida*. We well know how such malformations tend to become hereditary; and the sacral dimple might be called the scar of the lost tail. The hereditability of such malformations is well marked. When Dr. Wilson crossed a Manx tomcat with a common cat, seventeen out of twenty-three kittens were tailless; but when female cats of the Isle of Man were crossed with common tomcats all the kittens had tails, though somewhat shortened. Prof. Ecker has suggested a less fanciful explanation of the origin of the sacral dimple. He supposes that the later inward curving of the tip of the much straighter coccyx in the fœtus—which is connected with the skin by the caudal ligament—draws the corresponding spot on the skin into a funnel shape of greater or less depth. On the other hand, Ecker would rather regard the *glabella coccygea* as the lower fontanel, or later point of closure of the sacral canal.

The embryonal processes and normal conditions of formation thus briefly sketched are sufficient in general to permit most of the cases of so-called tail-formations in men, which occur with tolerable frequency, to be recognized as easily explainable irregularities of natural growth. The case deviating least from the normal condition concerns only the skin-covering, and exhibits itself in an excessive hairiness of the sacral and coccygeal region (*trichosis sacralis*). We have seen above that this spot in the embryo regularly bears a hair-twirl, which is not rarely prolonged into a hairy pencil or taillet. We can hardly consider it an important variation if this hairy taillet is exceptionally not absorbed, but endures and grows stronger after birth. In the so-called hairy men we evidently have persons in whom, according to all appearance, the wool-hair of the fœtus has grown to a far greater extent, or at least possesses the same properties of alignment and direction. The chief physician of the Greek army, Dr. Bernhard Ornstein, having observed several cases of extraordinarily abundant hairiness in the sacral region among Grecian recruits, has given continued attention to this phenomenon, and has determined some very remarkable cases of it. The most striking of these cases was that of the twenty-eight-year-old recruit Demeter Karus, of the eparchy of Corinth. The whole sacral region appears to be cov-

ered with a thick, dark-brown hairy growth, about three inches in length, which spreads over on to either side. The hairs lie more smoothly on the border of the skin covering the sacrum, while in the middle they curl out into two strong tufts. The man is about five feet two inches high, and his yellowish-brown skin shows elsewhere on his whole body less than the usual hairiness. The recruit said that he was born with this unusual hair on his back, and that he had even in youth suffered on account of it from the curiosity of the people of his native village. He said also that the growth had once been so strong that he had braided the hair into queues and tied it in front, but that since then he had preferred to cut it from time to time. To test the accuracy of this assertion, Dr. Ornstein forbade his cutting the hair for a considerable period; and eight months afterward (December, 1875) the sacrum-hair had grown to double its former length, or to six inches; so that the recruit's assertions respecting it were shown not to be incredible.

Prof. Virchow accompanied the detailed communication of this case to the Berlin Anthropological Society* with a few well-chosen words prefacing the opinion that we have perhaps to deal here with a *spina bifida occulta*, which is indicated exteriorly, as occurs often in the case of moles, mother's marks, etc., by augmented growth of hair. There has existed, he said, for a considerable time, a doctrine—we might call it a superstition—in pathological anatomy, which is called the law of the duplication of cases. "On the same morning that I received the letter from Athens, it was told me that there was a corpse in the Pathological Institute which exhibited an unusual hairiness on the back." Since we had to do in this case with a *spina bifida occulta*, there might perhaps be a similar pathological cause in the case of the Greek recruit. But the hair on the Berlin woman's back sprang from a higher spot, and did not denote the more thickly haired coccygeal region of the human embryo. In continuation of these efforts of Virchow to follow up these abnormal formations in the human body resembling animal shapes to their pathological causes, and in order to learn how to obviate them, Surgeon-General Ornstein kept watch upon the parts of the body concerned in the eruption, and in the next year (1876) succeeded in establishing a second case of well-defined sacral trichosis, marked by thick, dark-brown hair, extending to the coccygeal region. In the next year (1877) ten other cases fell under his attention, by which it became evident that this sacral hairiness was not rare in Greece and the islands of the Ægean Sea; and he was convinced that in all the cases the basis of it was normal and there was no question

* Sitzungsberichte der Berliner anthropologischer Gesellschaft in der Zeitschrift für Ethnologie, 1875, pp. 91 and 279.

of a *spina bifida*. Virchow's law of the duplication of the cases had not maintained itself under the first test. Of the various other persons of this kind whose photographs Dr. Ornstein took, we mention the recruit Q. G. Nikephorus, of Siphno, twenty years old, in whom the thick brown hair of the sacral trichosis is very sharply defined, and quite covers the sacrum. The hairs were in this case from one and a half to two and three quarter inches long, while no abnormal hairs were visible on the rest of his somewhat slender body.

It requires no particular gift for adapting evidence or of divination to infer from these cases of sacral trichosis, so frequent in Greece, which are easily explained by reference to the embryonic hairy covering, that the representations of Silenus and the fauns in ancient Grecian art, in which this part of the body is furnished with a tail-tuft of hair, may be traced back to casual observations of such cases in real life. A strikingly naturalistic illustration of this view is afforded by the Silenus with the Bacchus child in the Louvre, in which, instead of the isolated horse-tail-like pencil rising from the sacrum, characteristic of most figures of the kind, the whole sacral region is represented as well haired, while the central lock is simply more strongly prominent (Fig. 6).

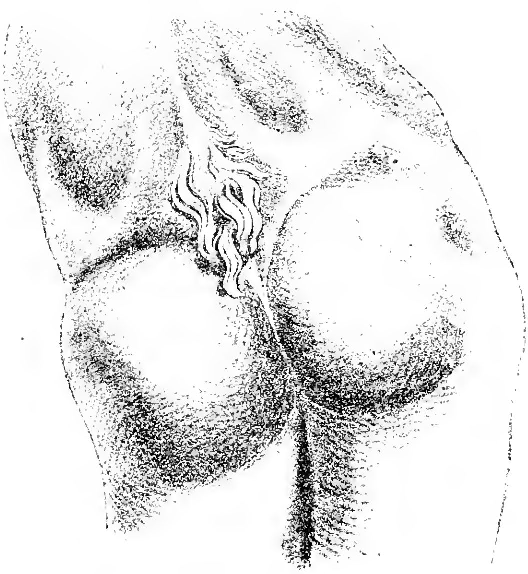


Fig. 6.—Part of the Back View of the Silenus with the Infant Bacchus, in the Louvre. From a Drawing by F. Schäfer.

What might be called "hide-bound tails," of which Dr. Bartels describes a well-marked case that occurred in his own medical practice, incline more decidedly to the order of real malformations. In a three-days-old child, the skin over the coccyx formed a three-sided lump of about the shape of the tail-termination of the embryo. This lump was about seven eighths of an inch long, rose several lines above the rest of the skin, and was separated from it by a plainly defined groove. The pointed lower end of the swelling seemed to lie directly over the anal orifice, which was very narrow, and must have been operatively enlarged after the

point of the excrescence had been loosed from that part. The formation did not contain any vertebra; the coccyx lay rather beneath, and there was evidently in this, as in a similar case observed by Labourdette, a question of a so-called intercepted formation from the coccygeal lump period. The hide-bound tail offers an enlarged copy of the embryonal coccygeal lump, and exhibits that lump, which in the normal development reverts and is merged in the buttock, apparently maintained and associated, as a rule, with an imperfect development of the anal orifice (Fig. 7).

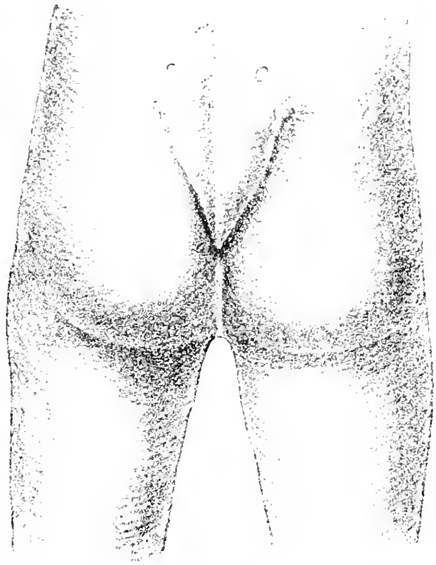


Fig. 7.—Three-days-old Boy, with Hide-bound Tail. From Dr. Max Bartels.

A third class is composed of the "soft tails," which depend freely from the sacral and coccygeal region and are the most frequent. They have sometimes the form of a swine's tail drawn out to a point; sometimes that of a thicker fleshy appendage only slightly rolled at the end. Such soft tails, which belong to the largest of their kind and are both naked and hairy, have been observed and described, among others by Blancart, König, Elsholtz, Schenk, von Grafenberg, and Greve. The last author sent a tail three inches long (Fig. 8), which he had amputated from a boy eight weeks old, to Prof. Virchow for a more thorough examination, and he found that it was not a simple case of skin formation, but that there lay within the inner cell-texture of the skin a fatty bundle penetrated by large vessels. In this species of malformation—to which the case delineated in Virchow's Archiv für pathologische Anatomie, vol. lxxxiii, No. 3, seems to belong—we have to do, not with a simple impeded formation, such as the last-mentioned case is considered to be, but with the outgrowth of a part existing in the embryonic plan, which, however, disappears in regular growth, into a monstrosity *per excessum*, as was the old form of expression. In many respects these cases are atavistic. The

Fig. 8. — Amputated Tail of a Boy Eight Weeks Old. From Greve.

surplus length of *chorda* persists without there being any vertebræ formed upon it.

Real vertebral tails, in which the vertebra-containing part of the embryonal tail remains without being grown over and the coccyx preserves its original straighter direction, have been, if we may trust the older anatomists and physicians, not very rarely observed. Surgeon-General Ornstein, a few years ago, carefully studied such a case in Athens in a Greek from Livadia, twenty-six years of age. There was in this case a conical tail, free only at the tip, about two inches long, within which three vertebræ might be felt by pressing upon it. It did not, however, hang perpendicularly down, but the coccyx was slightly, though less than in normal cases, bent inward. Notwithstanding its apparent firmness, this little movable tail was not distinguishable by the color of its skin from its surroundings. It was hairless, although the sacral region was very hirsute. The free part was not half as long as the whole.* While only three shrunken vertebral fragments could be felt in this case, free tails of like character have been described by several of the older authors in which the normal number of vertebræ appears to have been exceeded by four. Dr. Thirk, of Broussa, in 1820, described the fat-tail of a Kurd, twenty-two years old, which formed a thick lump and contained four surplus vertebræ. Thomas Bartholinus, also, told in the seventeenth century of a tailed boy who had more than the regular number of vertebræ in the coccyx. Such cases represent true atavistic formations, but have never been verified with as much exactness as is desirable, although the possibility of an appearance of the kind does not admit of reasonable doubt. The phenomena might, in fact, be more frequently recorded were it not that such formations, so long as they do not occasion distress, are carefully concealed for fear of reproach falling upon those who bear them and upon their mothers.

Dr. Bartels makes some pertinent remarks concerning the bearing of these exceptional but not at all rare tail formations among men upon the myths of "tailed races"; and Mohnike has made a valuable collection of the travelers' stories on the subject from the most ancient times. Mohnike believes that the older myths generally relate to apes; but this is not very probable, for the erect anthropoids, which most resemble man, are as tailless as he. The derivation from the custom of many savages of wearing animal skins with the tail hanging down upon the right side is more probable. Schweinfurth also observed among the women of the Bongos a custom of wearing a palm-leaf tail, bound on so as to produce a naturalistic appearance.

* A fuller description may be found in the Zeitschrift für Ethnologie, vol. xi, 1879.

The myths of tailed human races constantly revert to the East Indian islands; and the Dutch captain, L. F. W. Schulze, sent communications to the Berlin Anthropological Society in 1877 concerning cases* partly observed by himself, which were regarded by Dr. Bartels as fully trustworthy. These communications tell us nothing new, for the phenomena occur in cultivated Europe as well as in remote deserts and lone islands. Other reports, like that, for example, of Julius Kögel concerning the Dyaks of Borneo, speak of the frequent occurrence of tailed individuals. Hence a low, beastly race has been supposed, in which atavistic formations occur still more frequently than among higher races further removed from the original condition. Still other reports, and more recent, mention fully tailed human races.

Even if a phenomenon of this kind were established we need not, as Dr. Bartels has justly remarked, conceive of a still living middle form between man and beast. "We must consider," he says, "that we are all the time dealing with insular populations who have been crowded out of the possession of their coast and harbor regions by people of other races and driven into the hardly accessible interior of the country, where they have been compelled to practice, for a length of time we can not estimate, a constant inbreeding—a regular series of marriages within their own tribe. In this case there might, at some time in the past, as has happened with other men, have occurred an external tail, as a casual abnormity at first, but which might afterward, in the course of generations, become transmitted to many persons by inheritance. For it has been shown by researches in this interesting field of pathological anatomy that nothing is more easily transmissible than malformations. In illustration of this fact we need only mention here the well-known inclination to the inheritability of what are called mother's marks and hare-lips, and the large teeth of the Melanesians of the Admiralty Islands and the island of Agome, which have been described by Mr. Miklucho-Maclay.† In a similar manner Lord Monboddo, in the last century, explained the tailed men of Borneo as a people afflicted with a hereditary malformation, and compared them with six-fingered families.‡

In agreement with this is what the Wesleyan missionary George Brown related in 1876 concerning a formal breeding of a tailed race of men in Kali, off New Britain. "Tailless children," he says, "are slain at once, or they would be exposed to general ridicule."# A tailed family of princes have borne rule in Rajpootana and are earnestly attached to the ancestral mark. Dr.

* See Kosmos, vol. i, p. 166.

† Bartels, p. 4.

‡ Kosmos, vol. v, p. 149.

Mohnike, p. 3.

Quatrefages also speaks of the appearance of such varieties of men as very probable. The care just mentioned as having been taken of the malformation is all the more striking because the tail, as has been shown in the European cases, is in sitting and riding no very pleasant feature. They tell of canoes in the East Indies that have holes made in the benches of the rowers. But it is not an idle thought in this matter to suppose that the benches, like the old German stools, were furnished with holes for ornament, or in order that they might be more easily handled and disposed of, and the incident can not be regarded as confirming the popular legend. The result of these investigations is, as a whole, that a formation, homologous even in outside appearance with an animal's tail, is originally present in the human fœtus, and loses its external characteristics at a later period of life through arrest of growth, inversion, and waste. If these processes occasionally fail to take place, the tail-feature is nevertheless not visible in the grown man, and we can not draw from such malformations, even if they appear frequently in a single race, any one-sided conclusions respecting there having existed a former animal-like condition. For it may be supposed with much more probability, from the similarity of the forms in this feature of man and the anthropoid apes, that their common ancestor had already shed the external tail; and hence that the prolongation of the chorda in the embryo, with no vertebra contained in it, may be regarded as a reminiscence of a still earlier ancestral form.

A discussion in the International Geological Congress at Washington, on correlation of strata, was opened by Mr. G. K. Gilbert, of our Geological Survey, who spoke first of local methods, where one rock lies upon another. Physical continuity was a means of correlation, and perhaps the best method, but was subject to limitations. Traces were rarely possible for great distances. Indirect methods must be resorted to. Beds of similar lithologic formation could be regarded as chronologically similar. Another method was the sequence with which the deposits were laid. Layers following in sequence in different localities argued the same conditions. There were limitations, however, to the use of both these methods. Physical breaks afforded a fourth method of correlation, to which the limitation would probably be distance. Simultaneous relations of bodies to some physical event often afforded valuable evidence. This method had been useful, both at Salt Lake and on the Atlantic coast. Other aids in correlation were the relation of deposits to some geological climate and the evidence of similar physical changes. The similar action of gases in different beds showed chronological similarity. This method was largely limited by local climatic changes, and generally the physical methods mentioned were all valuable at short range but of little use at long range. The theoretical methods, in which floral and animal life are called in, are perhaps more accurate. Of these are divergence from a status at a fixed date, and the relations of the fauna contained in the deposits to climate. The value of a fossil species for purpose is dependent greatly on the length of its life and the range of its space. Long life is a drawback, that makes the cor-

relation vague. Prof. Zittell, of Munich, did not think the method of correlation by plants accurate. Of animals, those of the land were most valuable. He spoke of the difficulty of correlation in some countries where vertebrate animals are not found in many of the deposits. Prof. Marsh agreed with the other speakers that vertebrate animals afforded the best and most accurate material for correlation. Prof. Charles D. Walcott spoke of the advances that had been made in the study of correlation, and illustrated his positions by reference to the Cambrian strata of North America. Prof. James Hall begged that geologists in search of correlations should not neglect physical methods, and described an early attempt at correlation made by himself in trying to connect the rocks of western New York with the deposits of the West.

COMMUNICATION WITH THE PLANETS.

By M. AMÉDÉE GUILLEMIN.

STRIKING discoveries in astronomy, of a character to excite the public mind, have been rare in recent years. Those who have kept in current with the work that has been done in that science are not ready to believe that this is because progress has not been made in it. As evidence of the new work accomplished by its students, and potentially fruitful work, too, we cite the preparation of a map of the sky, accomplished by the aid of photography, which gives the exact position of the stars to the fourteenth magnitude. The co-operation of observatories certainly assures the success of this immense work, which is now in process of execution. La Nature has made known the beginnings and has kept its readers in the current of the very minute and profound preliminary studies, without which the undertaking of operations of an extreme delicacy might have been compromised. It has also made clear the importance of the results to be obtained, and of the various consequences that would necessarily accrue from them. The problems of parallax or of stellar distances, of the proper motions of the stars, of nebulæ, the search for minor planets and new comets, everything relative to the constitution of sidereal systems, may, by an attentive study of the plates of the new celestial maps, receive positive solutions. A new horizon is thus opened to science. These are not sensational novelties, like the appearance of a comet with a long, nebulous tail, which attracts the attention of idlers to the sky; but the importance of astronomical observations is not measured by the noise they make in the public ear. Yet, if the prize of a hundred thousand francs, which an honorable lady has recently bequeathed to the French Academy of Sciences, should be gained by some one, the resultant emotion would be legitimate. To establish voluntary and direct communication between the earth and a

planet, or rather between its inhabitants and the inhabitants of a planet, would be something to sharpen the curiosity of the whole world. I do not see that astronomy or mankind would gain anything by it, but what conjectures, what paradoxes, what high fancies, we should enjoy if it were carried out!

The Academy is said to be disposed to accept the legacy, by virtue of a clause like that which makes the Bréant prize an annual recompense allotted to the authors of discoveries tending to advance the solution of the problem of a cure for cholera. In the same way, the income of the capital bequeathed by Madame Guzman will work in favor of investigations relating to the constitution of the heavenly bodies. I do not think I am hazarding much when I assert that it will be a long while before the new prize is awarded, in its totality at least. But this was doubtless not the opinion of the testatrix. Without going deeply into the question—for that would require a long discussion—the probable correctness of my prediction can be shown in a few lines.

To any one well acquainted with the present knowledge possessed by astronomers concerning the physical aspect of the stars of our system, it is evident that only two of the planets are in a condition to encourage the hopes of those who believe in the possibility of interplanetary communications, to wit, the moon and Mars—the moon especially. Its small distance of 240,000 miles, the clearness of its disk, the facility with which minor features can be distinguished upon it with the telescope, the absence of all cloudiness that can conceal spots upon it, make our satellite an eminently fitting body to which to send signals from the earth. We must believe that the inhabitants of the moon have not thought of this, or the numerous observers of its disk, the industrious authors of the lunar maps, the Beers, Mädlers, Schmidts, at least, would have perceived the signals. But stop. Are there, can there be, inhabitants in the moon, where air and water are absent? If there is any point generally admitted, it is the negative of this question.

Under these conditions, it seems idle for us of the earth to trouble ourselves about means of answering the inhabitants of the moon, or of ourselves provoking signals thence; and this is a pity, for the second heavenly body to be questioned, the planet Mars, is infinitely less favorable for the establishment of an inter-astral telegraphy. At its most favorable oppositions, Mars is still 42,000,000 miles from us, or a hundred and sixty times farther than the moon; while the diameter of its disk is only 25″. According to Schiaparelli, the smallest objects visible on its surface under the most favorable circumstances—such as a bright spot on a dark ground, or a dark spot on a bright ground—must have a diameter equal to a fiftieth part of that of the planet, or about

eighty-five miles. This minimum can, it is true, be reduced by using large objectives permitting stronger magnifying; but even then it is certain that luminous signals, for example, visible from the earth on Mars, must have enormous dimensions.

The inhabitants of Mars, if more advanced in astronomical knowledge than we, as one of our imaginative astronomers supposes they are, would have, in case they should desire to start an exchange of telegraphic communications with their earthly neighbors, to give their signals diameters of miles in every direction. But would they think of it? The reciprocal question to this is the one that puzzles me. The earth, during all the oppositions of Mars, is in conjunction to it. It is lost in the rays of the sun, and invisible from Mars, unless it is in transit over the sun's disk. Then it is a little black, round spot, on which we have every reason to suppose the Martian astronomers will be able to distinguish nothing. The earth will be better situated at the quadratures, but also at a much greater distance.

I stop here, not desiring to discourage absolutely the candidate for the prize of one hundred thousand francs so generously and so imprudently offered to investigators. But my conclusion, which I have sufficiently foreshadowed, is, that the problem of interplanetary communication is still far from solution; and I believe I shall never be contradicted by real astronomers. I have faith in the indefinite progress of the science, while I am convinced that there are limits to this progress; but I believe also that there is no profit in letting the imagination chase chimeras, and I am free to avow that the desired communication is such to my eyes.—*Translated for The Popular Science Monthly from La Nature.*

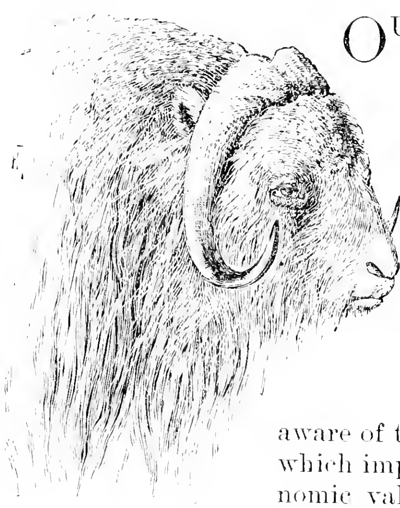
The compilation of a digest of the literature of the mathematical sciences was suggested at the American Association by Prof. Alexander S. Christie. The digest should contain everything of value hitherto done in these sciences logically arranged, with each truth or method referred to its discoverer, and the whole thoroughly indexed. Mathematicians throughout the world should be invited to engage in the preparation of the work, and the co-operation of the British Association especially should be secured.

There is no doubt that a kind of perception of light exists even among beings that have no visual organs, or where such organs can not be brought into play. The property is perhaps not unlike that by which the growth and movements of plants are largely determined by the relations of light. A number of cases of such skin perceptions of light—which we might call dermatoptic or photodermatic—have been collected and described by M. Victor Willem in a French journal. Tremblay observed that hydras prefer the more illuminated parts of the medium in which they move; and the same has been remarked by Haeckel, Pouchet, Engelmann, and Loeb in *Protozoa;* and other authors have observed in *Bryozoa*, cœlenterates, *Spongiaria*, worms, larvas of arthropods, and isolated organs of mollusks

that they move or are retracted under the influence of light, and in a general way indicate by their way of living the possession of some kind of a perception of light. M. Dubois has studied the contraction of the siphon of the *Pholas*, and M. d'Arsonval has shown that the muscle of the frog is directly excitable by light. M. G. Pouchet observed that larvæ of *Erystalis tenax* tried to get out of the light; and as they acted in the same way after their cephalic antennæform organs had been taken away, he asked whether these buds of future eyes were not adapted to perceive light, or whether the fore surface is not possibly sensitive to it. Engelmann found that certain *Protozoa* moved or remained still according to the character and intensity of the light—not on account of a direct action upon them, but because of the want of oxygen. M. Graber, since Darwin, has shown that the earth-worm, although it has no eyes, is sensitive to light and avoids it, and its sensitiveness seems to reside in its whole body. Finally, M. Loeb has recently made a series of important researches, whence he concludes in favor of a complete identity between the heliotropism of plants and the influence of light on animals, and that a number of blind forms are sensitive to light. The seat of this peculiar form of sensitiveness has not been clearly determined, but is probably in a pigmentary layer under the cuticle. We likewise know nothing certainly of the nature of the sensation. Some think it may be akin to sight, but vague and rudimentary; while M. Forel would compare it with sensations of touch or of temperature. Photo-dermatic sensibility reaches to the quality as well as the quantity of light, and M. Graber has shown that blind animals prefer some colors to others. But the data on this point do not all agree.

THE MUSK OX.

By HORACE T. MARTIN.



OUR first introduction to the musk ox (*Ovibos moschatus*) carries us back over one hundred and fifty years, when M. Jeremie made his voyage to the northern parts of our continent, and, returning to Paris, took with him a sample of wool obtained from an animal he called the *bœuf musqué*. This name was also employed by Charlevoix, writing from Canada in 1744.

Scientists were thus made aware of the existence of a large mammal, which impressed them at once with its economic value; yet has it refused to come within the range of their keen observation with a persistence unequaled by any animal of its size and importance. It was many years later that the first scientific

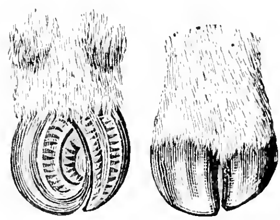
description appeared, given by Thomas Pennant from a skin sent to England by Samuel Hearne, and all acquaintance with the creature was derived from the arctic explorers (Drage, Dobbs, Ellis, Hearne, Parry, and others), who in general terms describe its appearance and give meager accounts of its habits. Dr. Richardson, in 1829, sums up the available information, and adds a few remarks of his own, which refer principally to the specimens then exhibited in the British Museum. Audubon, in his valuable history of the Quadrupeds of North America, published in 1854, is confined almost to a literal copy of Richardson's account; while so late as 1859 Spencer F. Baird, in his ponderous volume, the Mammals of North America, dismisses the subject with a reference of barely twenty lines. His words, however, are significant; for, while he admits that the animal furnishes a most interesting study, he laments our scant knowledge of this sturdy arctic inhabitant.

The special inquiry made three or four years ago by the Government of Canada, as to the resources of the Great Mackenzie Basin, furnishes data of utmost value: the enterprise of the modern press in ferreting out and bringing to our notice every item which concerns itself with the great questions of commerce and social economy, and the progress made in polar research during the last thirty years, contribute many facts in connection with the study of the musk ox; and we are enabled by the gathering and arranging of these to give in a more complete form the history of this animal.

In systematic zoölogy the place accorded to the musk ox is intermediate between those of the sheep (*Ovis*) and the ox (*Bos*), and for its special accommodation a new genus has been created, "*Ovibos*." Most writers notice its resemblance in many ways to the buffalo or bison, and it undoubtedly has much affinity with this species. A peculiar prominence is given in all early records to the description of the horns of the musk ox, which, though valuable to the Eskimos in the making of such commodities as cups, spoons, etc., by no means seem to be of so much importance, yet in every account the most minute particular of these appendages is repeated. Doubtless much of the character of the musk ox depends on the horns; still, it should be noted that the descriptions above referred to apply only to the bull, whose horns meet on the forehead, bend sharply down, and curve gracefully upward and outward; the cow's horns are more similar to those of the bison, or even may be compared to the horns of our domestic cattle. The skull of the bull musk ox is remarkable for the development of the eye-orbits, which project sufficiently beyond the plane of the frontal bones to compensate for the interruption the horns would otherwise make in the range of vision. The musk

ox, however, does not seem to rely greatly on keenness of sight, far less on acuteness of hearing, for the ears are of small dimensions, and are completely covered by the heavy growth of fur about them. The organs of scent are evidently more highly developed, and they exact of the hunter his greatest cunning. Vasey says the hoof-prints resemble those of the barren-ground caribou so closely as to easily deceive the unaccustomed eye, and concludes a short description of the under parts of the foot with the illustration here reproduced. The external hoof is rounded, the internal pointed.

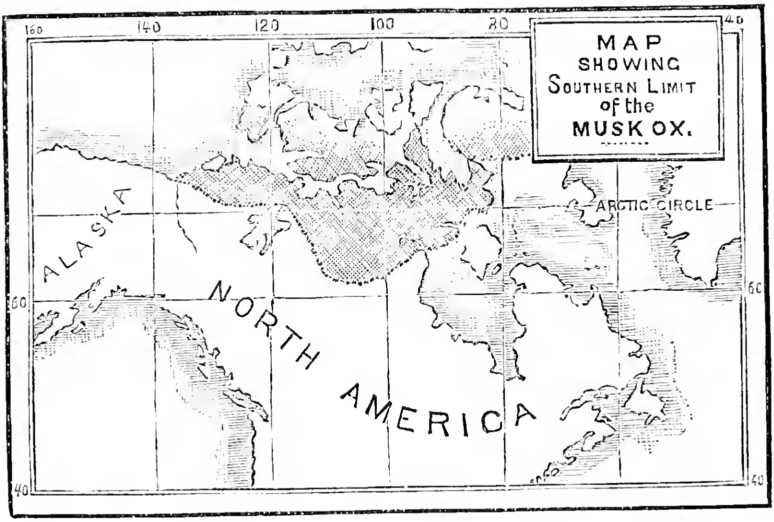
Much diversity of opinion exists as to the size and weight of the animal, and it is evident some statements have been made from very limited observation. Richardson compares the size of the musk ox to that of a Shetland pony, while others assert the dimensions to be quite equal to those of the bison; and whereas the weight has been given as from three to four hundred pounds in the one case, other records claim twice and even three times these figures as the weight of an adult specimen. The addition of from three to six inches of fur on the back, with hair flowing from the flanks to the length of from eighteen to twenty-four inches, gives an appearance vastly different from that of the bison, and the disproportionate shortness of the legs also tends to mislead; but, notwithstanding this, the measurements of the skin show the animal to be almost as large as the bison or buffalo, hence the latter approximation of weight is more correct.



In connection with the color of the hair, it should be observed that, while the summer pelage is usually brownish and corresponds with the descriptions generally given, in winter the animal's covering is a rich black on the head and shoulders, flanks and tail, the color shading beautifully into the milky-white disk on the back, known as the "saddle," while the face and the legs are prettily relieved with the whitish color.

The musk ox is gregarious, and although all early statements agree in estimating the herds as composed of from twenty to fifty individuals, later information greatly increases these figures, and frequent mention is made of herds numbering from two hundred to five hundred.

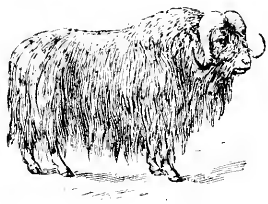
As recently as 1859 Baird says that, owing to the extreme scarcity of the musk ox, he knows of but one specimen to be found in all the museums of the United States. This scarcity, however, might be accounted for more by the fact of obstacles in the way of entering the territories inhabited by the musk ox than by the actual rarity of the animal. From the evidence of fossil remains, it is clear that the musk ox long ago roamed westward to Siberia, and found its way eastward even to the British



Isles; but the accompanying map, exhibiting the boundaries of its present range, shows how restricted is its distribution. In the regions of perpetual snow it wanders, making its way northward in summer, being found at the highest points our expeditions have reached, and returning in winter to its southern haunts, which seldom touch latitude 60°. Over the rugged wilds the creature loves to ramble, and, although its appearance indicates awkwardness of locomotion, it is said to run fast and to climb precipitous cliffs with wonderful ease. Its home is the "barren grounds" wherein vegetation is limited almost to a few lichens and the stunted spruce to which they cling. On this meager diet the musk ox fattened and lived free from the assaults of almost every enemy; for the Eskimo alone penetrated its domain, being urged thither by hunger and the desire to obtain the valuable pelt.

The flesh is much coveted by the Eskimos, and explorers speak in the highest terms of the relish afforded by the meat of the cow and the calf, although the meat of the bull is pronounced as offensively musky. Till within the last five years, in our markets, the pelt was worth fifty dollars, and was accounted a rarity; but

the extreme demand has led to more systematic methods of obtaining it; and whereas the total annual collection of pelts gathered by the Hudson Bay Company had not exceeded a few dozens, the figures have suddenly risen till the annual collection now is counted by thousands.



With the last remnants of the mercilessly slaughtered bison still in our markets, and the air filled with the protestations of theorists as to what *might* have been done to preserve those noble herds that thronged our prairies, we have history repeating itself under our very eyes in the case of the musk ox, and it is not venturing too rash a prophecy to state that the present ratio of increasing the catch will exhaust the supply within a decade.

OUR POPULATION AND ITS DISTRIBUTION.

LESSONS FROM THE CENSUS. III.

By CARROLL D. WRIGHT, A. M.,

UNITED STATES COMMISSIONER OF LABOR.

THE population of the United States June 1, 1890, as ascertained at the eleventh census, exclusive of white persons in the Indian Territory, Indians on reservations, and Alaska, was 62,622,250. This figure, considering the imperfections of the system under which it was ascertained, is quite satisfactory. It bears out the reasonable estimates made prior to the enumeration; it does not bear out unreasonable estimates. Barring inadequate counts in a few localities, which will occur under any system, I believe the statement of the population of the eleventh census to be fairly accurate for the whole country; it is certainly within a very small percentage of accuracy—a percentage which would largely disappear, but not wholly, under a census taken in accordance with the system outlined in the preceding articles of this series. Whether accurate or inaccurate, it is not worth while to quarrel with it; it must be accepted, and the political business of the country and all considerations carried on in accordance with it.

At the first census, taken in 1790, the population of the United States was 3,929,214. The following brief table shows the population at all the censuses, the positive increase during the intervening decades, and the percentage of increase:

Year.	Population.	Positive increase.	Percentage of increase.
1790	3,929,214	....	.....
1800	5,308,483	1,379,269	35·10
1810	7,239,881	1,931,398	36·38
1820	9,633,822	2,393,941	33·06
1830	12,866,020	3,232,198	32·51
1840	17,069,453	4,203,433	33·52
1850	23,191,876	6,122,423	35·83
1860	31,443,321	8,251,445	35·11
1870	38,558,371	7,115,050	22·65
1880	50,155,783	11,597,412	30·08
1890	62,622,250	12,466,467	24·86

The regularity of increase from 1800 to 1860 is striking, and then the influence of the war and of other elements is shown in the serious break in the regularity which occurs between 1860 and 1870, the percentage dropping from 35·11 in 1860 to 22·65 in 1870. With increased industrial and commercial activity the percentage rose again in 1880 to 30·08, but has now receded to 24·86. The influence of immigration upon this great increase in population, and the rate of natural increase since the decade from 1830 to 1840, are shown as follows:

Period.	Natural.	Immigration.	Total percentage.
1830–'40	28·87	4·65	33·52
1840–'50	26 15	9·68	35·83
1850–'60	23·73	11·38	35·11
1860–'70	15·40	7·25	22·65
1870–'80	22·79	7·29	30·08
1880–'90	14·40	10·46	24·86

Until the full data of the census for 1890 are available, it is impossible to make any careful study of the reasons why the natural increase of population should vary so greatly. The highest natural increase during the period of immigration, as shown in the foregoing table, was between 1830 and 1840, it having been 28·87 per cent, the lowest natural increase being during the last decade, when it was 14·40. It seems almost incredible that such a variation could actually occur in the natural increase of population; but this matter must be left for future consideration. The population at the last three censuses has been distributed over the country, in accordance with geographical divisions, as follows:

Geographical Divisions.	Population.			Increase from 1880 to 1890.		Increase from 1870 to 1880.		Increase from 1860 to 1870.	
	1890.	1880.	1870.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
The United States.	62,622 250	50,155,783	38,558,371	12.466,467	24·86	11,597,412	30·08	7,115,050	22·63
North Atlantic	17,401,545	14,507,407	12,298,730	2,894,138	19·95	2,208,677	17·96	1,704,462	16·09
South Atlantic	8,857,920	7,597,197	5,853,610	1,260,723	16·59	1,743,587	29·79	488,907	9·11
Northern Central	22.362,279	17,364.111	12,981,111	4,998,168	28·78	4,383,000	33·76	3,884,395	42·70
Southern Central	10,972,893	8,919,371	6,434,410	2,053,522	23·02	2,484,961	38·62	665,752	11·54
Western	3,027,613	1,767,697	990,510	1,259,916	71·27	777,187	78·46	371,534	60·02

By this table it will be seen that the largest increase during the last three decades has been in the Western division, consisting of Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, and California. This division increased its population from 1860 to 1870 by 60·02 per cent; in the next decade, 78·46 per cent; and from 1880 to 1890, 71·27 per cent. It is natural that the greatest increase should occur in the division named.

Some of the Southern States did not show as great a percentage of increase as they would have shown had the census of 1870 been more thoroughly correct; but the imperfections of the census of 1870, which imperfections showed an enumeration probably much less than the real population, when compared with the more accurate census of 1880, resulted in an exaggerated increase between those years; consequently, with the census of 1890 compared with the exaggerated increase between 1870 and 1880, the relative percentage of growth is apparently less; yet, on the whole, the Southern divisions show very satisfactory percentages, as will be seen by consulting the last table.

The increase and decrease of population during the decade of years from 1880 to 1890 show casually that in a very large number of counties the population has really decreased, and an examination of the figures by counties gives proof that in four hundred and fifty-five there has been an apparent loss of inhabitants, arising from an actual decrease in population or from a reduction of territory, the latter being the case in fifty instances, consequent upon the formation of new counties. A real loss occurred in only about one hundred and thirty counties, such losses occurring mainly in the central parts of Maine, New Hampshire, Vermont, New York, northern New Jersey and eastern Virginia, and some localities scattered through Ohio, Indiana, Illinois, Tennessee, and Kentucky. Considerable loss has occurred in southern Michigan and Wisconsin, while eastern Iowa has largely experienced a diminution in population. The ebb and flow of mining operations have resulted in a good deal of change in the totals of mining counties, as, for instance, such counties in Colorado have very generally lost in population, and with the exception of two counties the number of inhabitants in the entire State of Nevada has decreased. The statement as to loss in mining regions is also true of California. The increase, however, in our great Western domains has been over one hundred per cent. The Great Plains have increased rapidly, and so have the agricultural areas of the Cordilleran plateau. Northern Michigan, western and southern Florida, Arkansas, southern Missouri, and central Texas, exhibit a growth that is really phenomenal, and the southern Appalachian region has increased its population largely. Southern New Eng-

and, as well as the most of New York, Pennsylvania, and New Jersey, show the results of commerce and manufactures, where they are firmly established and constitute the leading occupations of the people, which has to a large extent been withdrawn from the country and been grouped in the suburbs of cities and large towns; so the population, which twenty or thirty or perhaps forty years ago did not increase in such localities, is, under the activity stimulated by profitable occupations, increasing rapidly; but in the central parts of Maine, New Hampshire, Vermont, and New York, where the transition from agriculture to commercial and manufacturing industries is still developing, population does not gain with very great strides. The changes from agriculture to commercial and manufacturing pursuits are indicative always of a transition from a permanent to an actively increasing density of population. This is evident in the upper Mississippi Valley and in Virginia, where the transition is becoming apparent. The areas known as the plains of the Cordilleran region are being peopled rapidly. This is particularly true in the northern portions. Cheap lands and easy tillage of the virgin soil are making the competition of Eastern agriculturists unprofitable, and so the farming population of the far Eastern States is recruiting the territory embracing the rich lands of the West. In Nevada we witness the peculiar spectacle of a loss of population resulting from the low condition of the mining interests. These facts as to increase and decrease give an indication of the ever-changing features relating to the density of population in great areas.

Taking the whole country, the progress of growth has been along the thirty-ninth parallel of latitude. The center of population, meaning thereby the center of gravity of the population of the country, each individual being assumed to have the same weight, was, in 1790, twenty-three miles east of Baltimore, Md. In 1890 it was twenty miles east of Columbus, Ind., five hundred and five miles west of the point at which it was located one hundred years ago. The variation of the center from latitude 39°, north or south, has been very slight, the extreme having been less than nineteen minutes, while the movement in longitude has been nearly $9\frac{1}{2}°$. On the basis of a uniform movement on the thirty-ninth parallel of latitude, the westward march for the first decade after the census of 1790 was forty-one miles; for the second, thirty-six miles; for the third, fifty miles; for the fourth, thirty-nine miles; for the fifth, fifty-five miles; for the sixth, fifty-five miles; for the seventh, eighty-one miles; for the eighth, forty-two miles; for the ninth, fifty-eight miles; and for the tenth, forty-eight miles, or an average movement each decade of fifty-five and a half miles. The position of the center of population at each census is accurately shown by the following table and the map which accompanies it:

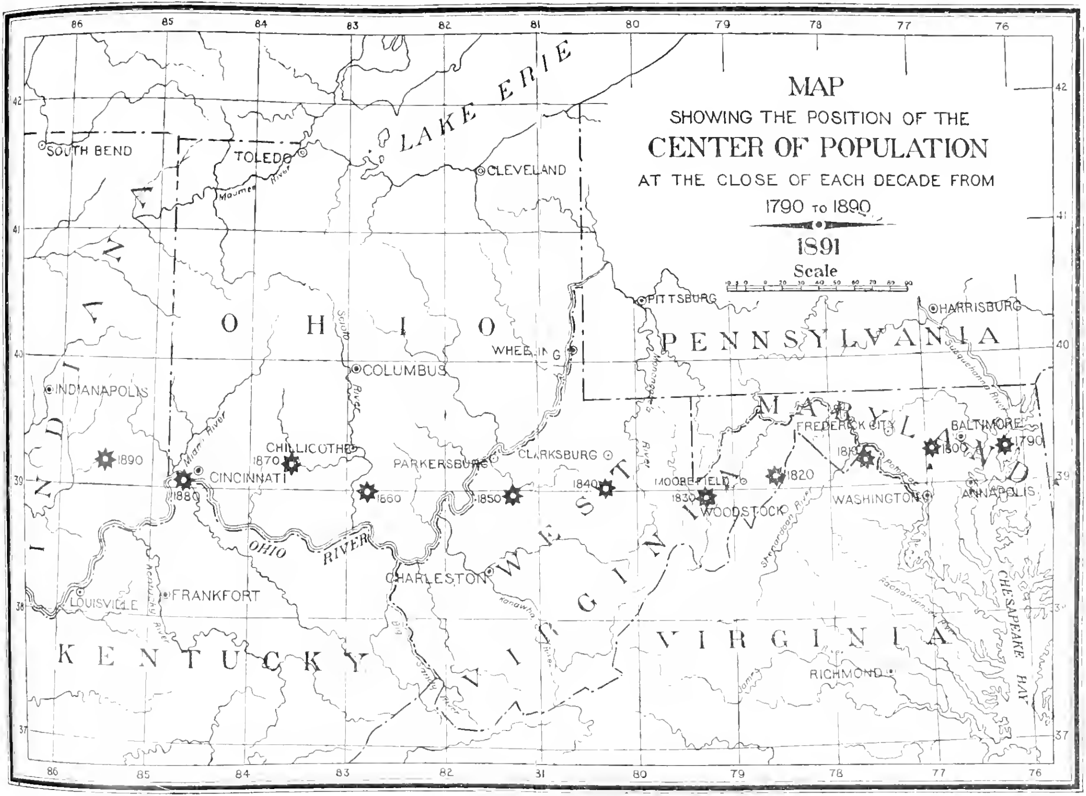
Years.	Approximate location by important towns.	Westward movement during preceding decade.
1790..	23 miles east of Baltimore, Maryland.....................	....
1800..	18 miles west of Baltimore, Maryland....................	41 miles.
1810..	40 miles northwest by west of Washington, Dist. of Columbia..	36 "
1820..	16 miles north of Woodstock, Virginia.....................	50 "
1830..	19 miles west-southwest of Moorefield, West Virginia...	39 "
1840..	16 miles south of Clarksburg, West Virginia...	55 "
1850..	23 miles southeast of Parkersburg, West Virginia............	55 "
1860..	20 miles south of Chillicothe, Ohio....................	81 "
1870..	48 miles east by north of Cincinnati, Ohio..................	42 "
1880..	8 miles west by south of Cincinnati, Ohio.................	58 "
1890..	20 miles east of Columbus, Indiana....	48 "

The official statements as to the center of population and as to the distribution of population in other respects, as will be shown, have been very carefully prepared by Mr. Henry Gannett, the able geographer of the tenth and eleventh censuses; but the statements have been made in various bulletins, and are here brought together in connected and compact form, with proper explanations.

It becomes interesting to know how the population of the country is distributed relative to what are recognized as drainage basins, which may be classified as the Atlantic Ocean, the Great Basin, and the Pacific Ocean. The classification of drainage areas under the first great division, that of the Atlantic Ocean, as a primary designation, has for its subsidiary divisions the New England coast, the Middle Atlantic coast, the South Atlantic coast, the Great Lakes, and the Gulf of Mexico. The Great Basin, for subsidiary divisions, has Great Salt Lake and the Humboldt River. The Pacific Ocean basin consists, secondarily, of the Colorado River, the Sacramento River, the Klamath River, and the Columbia River and their several great tributaries. The percentage of the total population, distributed over these drainage areas or basins, at the last three censuses, has been as follows:

Divisions.	1890.	1880.	1870.
Atlantic Ocean..............................	96·2	97·1	97·8
New England coast..................	7·2	7·6	8·5
Middle Atlantic coast..................	18·3	19·2	20·8
South Atlantic coast..................	6·8	7·4	7·3
Great Lakes..................	11·2	10·7	11·0
Gulf of Mexico..................	52·7	52·2	50·2
Great Basin..............................	0·4	0·4	0·3
Pacific Ocean..............................	3·4	2·5	1·9

The table shows that more than ninety-six per cent of the inhabitants live in the country which is drained by the Atlantic Ocean; that more than one half of the population live in the region drained by the Gulf of Mexico, and that nearly forty-four per cent of the entire population of the country are congregated


MAP
SHOWING THE POSITION OF THE
CENTER OF POPULATION
AT THE CLOSE OF EACH DECADE FROM
1790 to 1890
1891
Scale
LAKE ERIE
SOUTH BEND
TOLEDO
Maumee River
CLEVELAND
PITTSBURG
HARRISBURG
INDIANA
OHIO
PENNSYLVANIA
WHEELING
COLUMBUS
Scioto River
INDIANAPOLIS
Miami River
MARYLAND
FREDERICK CITY
BALTIMORE
CHILLICOTHE
CLARKSBURG
PARKERSBURG
CINCINNATI
MOOREFIELD
WASHINGTON
ANNAPOLIS
WOODSTOCK
Shenandoah River
OHIO RIVER
CHARLESTON
Kanawha River
WEST VIRGINIA
LOUISVILLE
FRANKFORT
Kentucky River
Big Sandy River
Rappahannock River
CHESAPEAKE BAY
KENTUCKY
VIRGINIA
RICHMOND
James River
Susquehanna River
1790
1800
1810
1820
1830
1840
1850
1860
1870
1880
1890

in the drainage area of the Mississippi River; that only four tenths of one per cent live in the Great Basin, and three and four tenths per cent on the Pacific coast. It shows further that the proportion living within the region drained to the Atlantic is steadily diminishing, while of this region the part drained to the Gulf of Mexico is becoming relatively more populous, as is the case in a still more marked degree in the Great Basin and the region drained to the Pacific.*

The tendency of population, as to topographical features, is best illustrated by a short table which has been condensed from the report of the census:

Regions.	Density of population.		
	1890.	1880.	1870.
Coast swamps	21·5	18·7	15·3
Atlantic plain	74·4	60·2	47·0
Piedmont region	69·5	55·8	45·8
New England hills	40·7	38·6	35·4
Appalachian Mountain region	49·8	41·7	34·3
Cumberland-Alleghany plateau	59·3	49·4	40·7
Interior timbered region	44·3	38·8	31·3
Lake region	25·1	17·6	12·1
Ozark Mountain region	22·8	16·0	10·3
Alluvial region of the Mississippi	23·6	18·2	12·2
Prairie region	28·3	21·2	14·6
Great Plains	1·4	0·4	0·1
North Rocky Mountains	1·1	0·4	0·2
South Rocky Mountains	2·1	1·7	0·7
Plateau region	0·7	0·5	0·2
Basin region	1·4	0·9	0·5
Columbian mesas	1·9	0·8	0·2
Sierra Nevada	4·9	4·6	3·8
Pacific Valley	9·1	5·2	3·5
Cascade Range	5·5	1·7	0·9
Coast Ranges	14·3	9·8	5·8

The greatest density, according to topographical features, is found in the Atlantic plain, it being 74·4 persons to the square mile, and the lowest density is in the Plateau region, it being 0·7 of a person, on an average, to the square mile. Four and three tenths per cent of the entire population of the country is to be found in the coast swamps area and the alluvial region of the Mississippi River. This population consists mainly of the colored race. Two and three tenths per cent of the entire population is found in the desert and semi-desert regions of the country. The mountain regions of the West hold 2·5 per cent, while about one sixth of the entire population is to be found in the Eastern mountain region.

If we examine the distribution according to altitude, it will be found that more than three fourths of the population live below

* Census Bulletin No. 47, by Henry Gannett.

1,000 feet above the level of the sea, and below 5,000 feet altitude nearly ninety-nine per cent of the inhabitants of the country find their residence. At great altitudes but few people are permanently residing. One sixth of the people live less than 100 feet above the sea-level. These, of course, reside along the seaboard and in the swamp and level regions of the South. Those living between 2,000 and 2,500 feet above the level of the sea are found largely on the slope of the great Western plains. Mr. Gannett finds that between 4,000 and 5,000 feet above the sea, but more especially between 5,000 and 6,000 feet, the population is greatly in excess of the grade or grades below it; and he attributes this appearance to the fact that the densest settlement at high altitudes in the Cordilleran region is at the eastern base of the Rocky Mountains and in the valleys about Great Salt Lake, which regions lie between 4,000 and 6,000 feet elevation. In this great region the extensive settlements at the base of the mountains in Colorado are to be found between 5,000 and 6,000 feet above the level of the sea. The mining operations above 6,000 feet, being restricted to the Cordilleran region, largely located in Colorado, New Mexico, Nevada, and California, account for the existence of the population at the altitude of 6,000 feet and more.

The population of the country is increasing numerically in all altitudes, but the relative movement is toward the region of greater altitudes, and is more clearly perceptible in the regions lying between 1,000 and 6,000 feet above the sea. The population is densest along the seaboard, the narrow strip containing our great seaports, as might be supposed; but the density diminishes, not only gradually but quite uniformly, up to 2,000 feet, when sparsity of population is the rule.

If we examine the population relative to latitude and longitude, it will be found that within those degrees in which are located the great cities the greatest density of population occurs, as, for instance, the area between 40° and 41° and longitudes 73° and 75°, containing the great cities of New York, Brooklyn, and Jersey City, with an aggregate population of 3,653,000 inhabitants; the single square degree between latitudes 42° and 43° and longitudes 71° and 72° degrees contains Boston and its suburbs, with 1,233,000 inhabitants, and that square between latitudes 39° and 40° and longitudes 75° and 76° holds Philadelphia, with 1,414,000 people. The square of latitudes 41° and 42° and longitudes 87° and 88°, which contains the larger portion of Chicago, has a population of 950,000. It is difficult to present the facts relative to the distribution of population in accordance with latitude and longitude for the whole country in this summary statement of salient points.

The distribution of population relative to mean annual rainfall indicates not only the tendency of people to seek arable lands,

but their condition as to general healthfulness. The average annual rainfall in this country is 29·6 inches, but the variations range from zero to perhaps one hundred and twenty-five inches. Gauging the distribution of the population in accordance with the average annual rainfall in different localities, some interesting points are observable, not only as to the number of inhabitants in the areas calculated, but as to the density of population. The greater proportion of the people of the United States are living in the regions in which the annual rainfall is between thirty and fifty inches Mr. Gannett calculates that about three fourths of the inhabitants of the country are found under these conditions; and, further, that as the rainfall increases or diminishes, the population diminishes rapidly. The density of population in regions where the average rainfall is between thirty and forty inches is 43·1 per square mile; in regions where it is from forty to fifty inches annually, the density is 59 per square mile; in regions where the rainfall is from fifty to sixty inches annually, the density is 25·1, and in the arid regions of the West, where the rainfall is less than twenty inches, being two fifths of the entire area of the country, less than three per cent. of the population finds its home. The population has increased rapidly in the regions having from thirty to forty inches average annual rainfall.

The importance of the knowledge of this distribution is supplemented by that with reference to the mean annual temperature, which is in the United States 52°, and the greatest density of population, as might be expected, centers on this pivot, ranging as it does from 50° to 55°. Either side of this range the density of population rapidly diminishes, as it was shown that it decreases rapidly outside the average rainfall between thirty and fifty inches. More than one half of the entire population of the country exists under a temperature between 45° and 55°, while seventy to seventy-five per cent of the inhabitants come within 45° and 50°. Where the temperature reaches 70° on the average, but a little over one per cent of the population finds its home, and the number living under a mean annual temperature above 75° is too trifling for consideration.

This line of facts leads to the consideration of the distribution of population in accordance with the relative humidity of the atmosphere, by which is understood the amount of moisture contained in it in proportion to the amount required to saturate it. This amount varies with the temperature; the higher the temperature, the greater the amount of moisture which it is capable of holding. The term is not a very exact one, but is relative and fairly indicative of conditions. The climate having very great influence upon certain classes of diseases, particularly pulmonary and throat complaints, a knowledge as to the distribution of popu-

lation in accordance with mean relative humidity becomes apparent, and the Census Office is doing a great service in this census, as it did in 1880, in ascertaining the density of population under different degrees of humidity. A condensation of the report by Mr. Gannett on this point will perhaps give as much valuable information to those seeking healthful locations as can be gained from any side of census statistics. It is well known that the atmosphere is heavily charged with moisture in those regions which lie along our coast, whether ocean, gulf, or lake. This is markedly so on the coast of Oregon and Washington, where the atmosphere is more highly charged with moisture than anywhere else within our territory. The Appalachian Mountain regions, and largely those of the Rocky Mountains, have an atmosphere heavily charged; but in the Piedmont region, east of the Appalachian, and in the upper Mississippi Valley, the moisture is less, while it diminishes still more on the prairies and the Great Plains; and in Utah, Nevada, southern Arizona, and southeastern California the minimum amount is reached. Of course the atmosphere is charged with moisture relative to the increase and decrease of the rainfall, as a rule; but throughout the upper lake region, while the atmosphere is as moist as that of the State of Washington, the rainfall is much less, and the coast of southern California has as moist an atmosphere as the Atlantic coast but a deficient rainfall.

The following table shows the percentage of humidity, in classified order, the percentage of the total population of the United States in 1870, 1880, and 1890, living according to the classification of humidity, and the density of population under the same conditions for the same years:

Groups.	Percentage of total population.			Density.		
	1890.	1880.	1870.	1890.	1880.	1870.
Below 50	0·49	0·44	0·35	1·14	0·80	0·50
50 to 55	0·69	0·40	0·24	1·44	0·67	0·30
55 to 60	0·46	0·27	0·16	1·35	0·61	0·28
60 to 65	1·39	0·87	0·35	2·89	1·46	0·45
65 to 70	36·68	38·44	37·31	31·46	26·41	20·26
70 to 75	54·40	54·39	56·76	40·07	32·10	25·74
75 to 80	5·34	4·79	4·49	14·21	10·22	7·36
Above 80	0·55	0·40	0·34	5·55	3·22	2·09

A glance at this table shows that nearly all the population breathe an atmosphere containing sixty-five to seventy-five per cent of its full capacity of moisture; that is, the atmosphere is from two thirds to three fourths saturated. In 1890, 57,036,000 out of 62,622,250 were found in this region; in 1880, 46,559,000 out of 50,155,783; and in 1870, 36,273,000 out of 38,558,371. The num-

ber of inhabitants living in a drier atmosphere was at each census comparatively trifling, numbering in 1870 less than half a million, and in 1890 less than two millions. In the moister atmosphere were found larger numbers scattered along the Gulf coast and the shores of Washington and Oregon. The most rapid increase has been found at the top and bottom of the scale, and particularly in the more arid region, where the population has nearly doubled during each of the last two periods,* showing that great areas that are not particularly favored by the elements are gradually being redeemed through the enterprise that marks our modern industrial era.

AN EXPERIMENT IN EDUCATION.

By MARY ALLING ABER.

FIRST PAPER.

IN October, 1881, a primary department was added to a private school in Boston, Mass., and the control of it given to me, for the purpose of making an experiment in education. While it was hoped the primary would sustain the usual relation to the higher departments, the proprietor † guaranteed freedom of action for three years, and generously furnished the means required. Gratitude is due to others also, especially to the teachers who assisted in some part of the work.

The aim of the experiment was to see if the child may not be introduced at once to the foundations of all learning—the natural and physical sciences, mathematics, literature including language, and history—and at the same time be given a mastery of such elements of reading, writing, and number as usually constitute primary education.

The experiment began with nine children between the ages of five and a half and seven years. With scales and measuring rod each child was weighed and measured, while such questions were asked as—" Have you been weighed before? When? What did you weigh then? How does your weight to-day compare with that?" The shyest children forgot they were at school, and chatted freely while watching and comparing results. By questions as to why a present weight or measure was greater than a former one, the statement " Children grow" was obtained. Questions about the causes of growth led to the statements " Children eat," " Children sleep," " Children play." A question as to whether any-

* See Census Bulletin No. 44.

† The name of the proprietor is withheld, in deference to a request made while the experiment was in progress.

thing besides children grows started a talk about animals, in which were given the statements "Animals grow," "Animals eat," "Animals sleep," "Animals play." In like manner similar statements about plants were obtained. The children were easily led from thinking of a particular child, animal, or plant, to the general conception and the use of the general term. This was the first lesson in natural science.

Recalling the first general conception reached in the science lesson a child was asked, "Nina, what did you say children do?" "Children grow," she replied. I said, "I will put upon the blackboard something that means what Nina said," and wrote in Spencerian script, "Children grow." In response to invitation the children eagerly gave the general statements gained in the science lesson. Each was written upon the board and read by the child who gave it. They were told that what they had said and I had written were sentences. Each child read his own sentence again. This was the first reading lesson.

One by one each child stood by me at the board, repeated his sentence, and watched while it was written. He was then taught to hold a crayon, and left to write his sentence beneath the model. When a first attempt was finished, the sentence was written in a new place, and the child repeated his effort at copying. In this manner each made from one to four efforts, each time telling what his copy meant and what he wished his effort to mean. None of this work was erased before the children had gone. This was the first writing lesson.

The children were led to count their classmates, their sentences on the blackboards, the tables, chairs, and other objects in the school-room. It was found that all could use accurately the terms one, two, three, and four, and the symbols 1, 2, 3, 4 were put on the board as meaning what they said, and their power to connect these symbols with the ideas that they represent was tested in various ways. This was the first number lesson.

The children were shown a magnetic needle and led to note the direction of its points when at rest, and the terms north and south were given. This was the first geography lesson.

After recess each child read his sentence, wrote it once, and then the subject of the science lesson was pursued further. After special answers to the question, "What do children eat?" the general statement was obtained, "Children eat plants and animals." Similarly, the children were led to give "Animals eat plants and animals." Then came the question, "What do plants eat?" One suggested the sunshine, another the rain, another the air, others the ground or dirt, for which the term soil was given. It was concluded that rain, air, and sunshine help plants to grow, and that some of their food must come from the soil; and the

general statement was given, "Plants get food from the soil." Then I asked, "Where does the soil come from?" Before wonder had given way to opinion, I said, "If you bring luncheons and extra wraps to-morrow, we will go to the country and try to find out where the soil comes from." A poem of Longfellow's was read, and the children were dismissed.

On the second morning the children came bounding in before nine o'clock, eager to find and read their sentences, which each did without hesitation; and until nine o'clock they amused themselves finding and reading one another's sentences, teaching and challenging in charming style. A few minutes later we started on our first field lesson in science. An hour's ride in street cars brought us to the open country. We went into a small field where a ledge of rock presented a bold front. "Children," I said, "an answer to our question is in this field. I wish each of you to find the answer for himself, to speak to no one until he thinks he has found it, and then to whisper it to me." Soberly they turned away, and I seated myself and waited. One child looked up at the sky, another at the ground, one began to pull over some gravel, another to dig in the soil—most to do some aimless thing because they knew not what to do. After a while some began to climb the ledge and to feel of it. Suddenly one of these darted to me and breathlessly whispered, "I think the soil comes from the rock over there." "Well, don't you tell," I whispered back. The sun climbed higher, but I waited until the last child brought me that whispered reply. Calling them together, I said: "You have all brought me the same answer. Why do you think soil comes from this rock?" They turned to the ledge, picked off the loose exterior, and showed me the same in masses at the base. A hammer was produced, with which they picked away the rock until it became too hard for them to break. I then said, "We see that a kind of soil comes from this rock, but what kind did we come to learn about?" "The soil that plants get food from," they replied. "How do you know that any plants can get food from this soil?" I asked. Instinctively they turned to the cliff; there were grasses and weeds growing in the talus at the base, and in crevices all up its front and sides; these they pulled, and showed me the roots with the rock soil clinging to them. Referring to the work with the hammer and comparing what they picked off with the hard mass underneath, they were led to variously describe the process of passing from rock to soil, and finally the statement was obtained, "Rock decays to make soil." After luncheon and a bit of play, the children were led to speak of rocks and soils seen elsewhere. Telling the children to shut their eyes and try to picture what I said, I told them that the earth is round like a ball, and is a mass of rock with a little soil on the outside of it; that if a giant could

take the earth in his hand, he might peel or scrape off the soil as we take a carpet from a floor, only the soil would seem much thinner than the carpet, because the earth is so big. All had traveled in railway trains, and had such impressions of their swiftness that this illustration was used: Suppose we start for the center of the earth on a train. Traveling day and night, it would take nearly a week to reach the center, and another week from there to the surface again; and all day while we watched, and all night while we slept, we should be rushing through the rock; and if we came out through the thickest layer of soil, it would take but a few seconds to pass through it. Then, telling them to open their eyes, I took a peach whose rind was thin and peeled smoothly from the pulp, spoke of the giant as I drew off the rind, and told them that the soil is thinner on the rock ball of earth than that rind on the peach. A few remaining minutes were spent in observing some pine trees and barberry bushes growing near.

On the third day, after reading the sentences already on the board—of which each child besides his own read one or more others—the following sentences were easily elicited: "Children eat plants and animals. Animals eat plants and animals. Plants get food from the soil. The soil comes from the rock. Rock decays to make soil." These were written on the blackboard, read, and copied by the children as on the first day. This was the natural science, reading, and writing of the third day. In number, the children added and subtracted ones by making groups and joining and leaving one another. In geography the first lesson was recalled, and the terms east and west associated with the appropriate points.

On the fourth day, after the children had retold what they had learned in the science lessons, they were shown a globe, and asked to imagine one as large as the room would hold, and how, to represent the earth, they must think it all rock, with only a thin layer of dust to represent the soil. In geography they were shown a map of the school-room, and led to see its relations to the room, and the relative positions of objects in the room and on the map. The next day, on another map, they traced their route to the country, and located the field and ledge of rock where their question was answered. In the fifth day's science lesson the children were led to speak of rain and wind as washing and blowing off the decayed rock and exposing fresh surfaces, and so increasing the decay, and to give the following summary: "Without decay of rock there would be no soil; if no soil, no plants, no animals, no people." In reading they had seventeen sentences, which they read without hesitation and wrote with some resemblance to the originals. In number, none failed to count to ten and to add

and subtract ones to ten. Each day a passage of poetry was read at the opening and closing of the session; little songs were taught, gentle gymnastic exercises were introduced between the lessons, and the free-arm movement in making long straight lines was added to their lessons in writing. This work of the first week is given to show how the experiment was begun. The classes entering the second and third years were started with different sets of lessons, but substantially on the same lines.

Throughout the three years reading was taught as in the first week. When there were enough sentences to make a four-page leaflet of print, they were printed and read in that form. The first transfer from script to print was made at the end of six weeks. The printed leaflets were distributed; the children merely glanced at them; as yet they were of less interest than the objects usually distributed. I said, "Look at the papers; see if there is anything on them that you have seen before." Soon one hand was raised, then another, and another. "Rosamond, what have you found?" "I think one of my sentences is here, but it don't look just like the one on the board." In less than ten minutes, by comparison of script and print, they read the whole leaflet, each pointing out "my sentences." After a few readings the children took the leaflets home, the sentences were erased from the boards, and the same process repeated with the new matter that was accumulating. The reader may think there was great waste of time and effort, since the new vocabulary and the written and printed symbols must have been forgotten almost as soon as learned. I expected the children to forget much, and was surprised to find that they did not. One morning in March a visitor who was looking over the accumulated leaflets asked to have them read. I told her they had been read when first printed only; but she urged the test, so I distributed them as they happened to come. The first leaflet fell to the youngest girl, and I think I was more amazed than our visitor when she read it without faltering. The visitor asked her, "What does palmately-veined mean, where you read 'The leaf of the cotton-plant is palmately-veined'?" The child replied, "I can show what it means better than I can tell it." "Show us, then, Marjorie," I said. The child drew on the board a fairly correct outline of a cotton-plant leaf, inserted its palmate veining, and turning to the visitor pointed to that veining. All the leaflets were read without help, nothing was forgotten, neither ideas nor words, as the visitor assured herself by questions.

No effort was made to use a special vocabulary, to repeat words, to avoid scientific terms; there was no drill in phonics or spelling; no attention was given to isolated words as words—a thought was the unit and basis of expression. In the science les-

sons the minds of the children were intent on the getting of ideas and the expression of them. Direction to look or think again usually sufficed to change vague, wordy expressions into clear, terse ones by giving the child clear and accurate conceptions. When the child's own vocabulary was exhausted, he was promptly helped to words by classmates or teacher, the effort being to use the speech of cultivated people.

At first the reading could by no means keep pace with the science lessons: from the mass of expressions obtained some were selected for the reading and writing matter. With increase of power to remember forms and combinations of letters and words, the number of sentences was increased, until what was gained in the science lessons was reproduced in the reading lessons. This increase was rapid. From the first field lesson two sentences—eleven words—only could be taken, while a field lesson near the close of the second year yielded ninety-seven sentences—over eleven hundred words. In the former the sentences were written on the board and read every day for five weeks; in the latter they were taken down in pencil by the teacher as the children gave them, arranged according to topics, printed, and presented in the printed form for the first reading. There was little hesitation in that reading, so vivid were the impressions from such a day out-of-door.

During the first year a little reading matter was drawn from lessons in literature and history. This was gradually increased during the second and third years. Still the sentences for reading were taken chiefly from the science lessons, because there could be more certainty of the child's having accurate and well-defined ideas as the basis of each expression, and the sentences could be more completely their own. In March of the first year reading-books were introduced. At the first trial they took Swinton's Easy Steps for Little Feet, and in twelve minutes read a page-and-a-half story. Of their own accord they sought and independently obtained from the context the meaning of all but two of the unfamiliar words, and gave to express the meanings either the exact words of the book or synonymous ones, for which those of the book were substituted. After this they read from books whenever such reading could be related to their other work—not much otherwise. While the production by the children of the bulk of their reading matter was a prominent feature, this was not the object of the experiment but merely an adjunct to the chief end in view. Nor were the science topics selected with reference to the reading matter, but on their own merits, mutual relations, and the capacities of the children.

As soon as a child's writing on the blackboard could be read by his classmates—copy being erased—he began to write at his

desk with pencil on unruled paper, the copy being still written on the board. When all had reached this stage, concert arm and finger movements were taught. During the second and third years the forms of the letters and combining strokes were analyzed, and each drawn on a large scale to accurate measurements.

The children saw no misspelled words, and were not asked to spell or write isolated words. During the first and second years they usually had a copy from which they wrote. In the third year they wrote original exercises. They were told to ask, when not sure how to write a word. The word was written on the board: no effort was made to have them think how a word should look, no matter how many times they had seen it written and printed.

Work in the natural and physical sciences, starting with broad conceptions, was carried forward along various lines, care being taken to show relations, and to lead the children to regard themselves as a part of nature. In mineralogy and geology, the paving, building, and ornamental stones most used in Boston; the ores of the principal metals, and their products; graphite and the making of pencils; gypsum and halite, were studied, each child getting his knowledge from specimens before him. Each was furnished with a testing outfit, including what a field geologist commonly carries, except the blowpipe and reagents to use with it; and these children from six to ten soon learned to use the outfit with as much skill as any adults whom I have taught.

In physics, lessons were given on extension and gravity; on the solid, liquid, and gaseous states of matter; on heat as the force producing expansion and contraction; on the evaporation, condensation, and freezing of water, with results in dew, clouds, rain, snow, and the disintegration of rocks; on movements of air as agents producing wind and storms; on the thermometer; on magnets, and two of their uses. In chemistry, lessons were given on air and its composition; on combustion and its products; on iron rust as to formation, and effects on iron; on CO_2 as an ingredient of calcite, and a product of breathing; on acids as tests for lime rocks containing CO_2; on the distinction between physical and chemical changes. In astronomy, a few lessons were given on the relations of sun and earth as causing day and night and the seasons.

Botany was pursued in the fall and spring months. In the spring the children planted a window garden, from which they drew plants for the study of germination and growth. From garden and wild plants they studied buds and their developments, and the forms, parts, and uses of some leaves, flowers, and fruits. A series of lessons on plants yielding textile fabrics and the manufactures from them was projected; but, owing to the difficulty

of getting plants in proper condition, the only portion given was that on the cotton plants. Fine specimens of these were received from Georgia, which kept fresh nearly two weeks, and showed all stages, from flower bud to open boll of cotton fiber. No work in zoölogy was done, save the giving of a few lessons on silk-worms and sheep, as yielding silk and wool. In physiology, lessons were given on the general parts of the body: on the joints, skin, hair, nails, and teeth; on the chest, and the process of breathing and its products; on food and digestion—all with reference to the care of the body, keeping the lungs from disease, and the true object of taking food. Geography was connected with science, history, and literature — the original habitat and migrations of rocks and plants, and the location of events leading to imaginary journeys. The forms of water and land, and a demonstration of the shape of the earth by the positions and appearances of vessels at sea, were gained in lessons to the country and the sea-shore. Boston and its surrounding townships were studied in connection with lessons in local history. Maps, globes, compass, and modeling clay were used throughout the course.

While the work in mathematics was not so fully developed on new lines as in other subjects, some work done in the first year may be of interest to the reader. In a field lesson of the second week, some distinguishing features of the apple, beech, pitch and white pine trees were noted and branches obtained. These branches furnished material for many days' number lessons. Apple leaves with their two stipules, pitch-pine sheaths with their three needles, beechnut exocarps with their four sections, and white pine sheaths with their five needles, were used by the children in constructing concrete number tables, which—picking up the objects—they recited as follows: "In one sheath of white pine are five needles; in two sheaths of white pine are two times five needles," etc. When the concrete table was familiar, the same number relations were written on the blackboard with figures and symbols. In this manner the children learned the four classes of tables as far as sixes. Meanwhile the study of geometrical forms and the plant lessons gave illustration and review. In January work with money was begun, and continued through the remainder of the year; but other opportunities to give practice in number were utilized—as, the six faces of the halite crystal, the six stamens of the tulip, etc. To get unworn coins we sent to the Philadelphia Mint. In two lessons the children learned the names and values of one copper, two nickel, four silver, and six gold pieces; in the third, by placing piles of coin side by side, they constructed and learned the table:

Two silver half dollars equal one gold or silver dollar.
Four silver quarter dollars equal one gold or silver dollar.

Ten silver dimes equal one gold or silver dollar.

Twenty nickle pieces equal one gold or silver dollar.

One hundred copper pennies equal one gold or silver dollar.

On the following day a new concrete table was prepared, and the dollar sign, figures, symbols, and decimal point were substituted for the words in the written work. The relative values of the lower denominations to one another were taught, and tables constructed and written. The different denominations of paper money up to the fifty-dollar bill were added to the coins; and this money—about one hundred and fifty dollars—was used in business transactions, which gave review of the number relations already learned, and taught those necessary to the construction and comprehension of the remaining tables. At the end of eight months the children could use and write numbers to one hundred and fifty, and the signs $+$, $-$, $\times$, $\div$, $=$, \$, and $\cdot$ (decimal point); and understood the value of position in notation to three places to the left and two to the right of a decimal point. Also, in the oral work with money, they readily used the fractions one half, one fourth, one tenth, one twentieth, and one hundredth; and most of them could write from memory the usual tables from one to twelve. In this first year no effort was made to do a defined kind or amount of work; the children spent from twenty to thirty minutes each day at some mathematical work, but progress and variety depended on their interest and capacities. A visitor who had spent forty years in teaching sat through one of these primary sessions. He expressed pleasure and surprise at the work of the children in science, reading, and other branches, but was incredulous, at first, about the work in number with the money at their desks, and the written work in figures and signs at the blackboards. He went around among the children, tested them, and watched to see if there were not some trick of parrot-like performance. Finally, convinced of the genuine comprehension of what they were doing by these children of six and seven, he said: "I should not have believed it on the statement of any man or woman whom I have known; but I have seen it with my own eyes."

It is a matter of regret to me that growing burdens of care forbade the development of the number work during the second and third years on the lines begun in the first year. To spend from a half-hour to an hour a day for ten years at mathematics, with no better results than the average boy and girl of sixteen can show, looks like a great waste of time and energy. May not the cause be twofold: First, that the beginning work is made silly by its simplicity, and insipid by being related to nothing interesting; second, that processes like the subtraction of large numbers and long division are pressed upon the child before his powers are adequate to their comprehension?

The last fifteen minutes of each day were devoted to literature. Selections with biography and anecdote constituted the materials for these lessons. Advantage was taken of birthdays, anniversaries, and natural phenomena. Storms furnished accompaniments to Lowell's The First Snow-fall, portions of Whittier's Snow-bound, Longfellow's Rainy Day, Bryant's Rain, Shelley's Cloud, etc. Flowers brought by the children were related to readings from Burns, Wordsworth, Emerson, Lowell, Bryant, Whittier, and Longfellow. Emerson's Rhodora was committed to memory and recited, a cluster of the purple blossoms being in sight. Selections were made with primary reference to their value. Biography was usually employed to heighten interest in literature; for its own sake when embodying noble sentiments—as Scott's struggle against debt, Sidney's gift of water to the soldier. By such tales of heroic effort and action it was hoped to develop courage, honor, and devotion to duty.

Aside from clear language in narration, accompanied by pictures of persons and places, and such reading as expresses the rhythm and meaning, no effort was made to have biography or selection understood. Many children have such an appreciation of melody that a fine poem well read will hold their attention. Just before Christmas, in our first year, I read a portion of Milton's Hymn on the Nativity, and said, "I hope you will some day read the whole, and like it." "Please read it all now," said several voices. So it was all read, and the children listened intently. Milton's picture was put away, and nothing said of him for a year. When his picture was again put on the easel, a hand was at once raised. "What is it, Tracy?" "I know who that is." "Who?" "Mr. John Milton." "What do you remember about him?" "He gave his eyes for liberty"—an expression which, so far as my knowledge of the child went, he had not heard from any one, but was his own terse summing up of the narrative he had heard a year before, when barely six years old. Most children have such an appreciation of justice and heroism that they will even walk more erectly after listening to a tale involving these qualities. I shall not forget how gravely and proudly fifty children withdrew from the school-room after listening to the story of Sidney's death. An unspoiled child has usually a vivid imagination; and it is as pernicious to meddle with the formation of his mental pictures in literature, as in science lessons to keep telling him what he can get from his specimens. The child's mind should be brought into direct contact with the realities in history and literature, and left to work at them with the least possible interference and guidance. If a child attempted to repeat a quotation or fact, accuracy was required, but he was not urged to remember. Much in the literature lessons was above the children's comprehension; but it was

thought well for each child to feel a breath from the mountains above and beyond—a breath whose coolness and fragrance he might feel without analysis or comprehension of its qualities. To have felt was enough. So we paid no attention to ordinary poems and tales for little children, but introduced the children at once to Longfellow and Emerson, Wordsworth and Scott, Milton and Shakespeare.

There was regular study of history for each year. Copies of early and late maps of Boston were given to each child; the older one was drawn on transparent paper, so as to be laid over the later one and show directly the changes and extensions into river and harbor. Colored crayon maps and pictures were used to illustrate the historical narrative. These narratives were drawn mostly from local events—as the settlement of Boston, with certain old Boston worthies as centers, about whom incidents were grouped; the beginning of the Revolutionary War with a visit to the Washington elm at Cambridge; some incidents of slavery and the civil war connected with Garrison. Extracts from diaries, letters, etc., were printed on leaflets and read by the children, who drew their own inferences. These readings from original sources were mostly confined to the third and fourth classes, as the language used was too difficult for children of the first two years. Sometimes gratifying volunteer work was done; as an instance, a boy of eight learned the whole of "Paul Revere's Ride," and recited it, standing at the blackboard and tracing on a colored map of Boston and its surrounding townships the route taken by the rider. This work in history was done by Miss Nina Moore—Mrs. F. B. Tiffany—who developed it with such skill as to fascinate the children, and to lead to her publications on these topics. (See articles in Common-school Education for September, October, November, and December, 1888; and the books Pilgrims and Puritans and From Colony to Commonwealth.)

The industrial part of the experiment was started at the beginning of the third year. Each child was provided with a bench and ten tools—ruler, try-square, scratch-awl, saw, vise, plane, chisel, brad-awl, hammer, nail-set. The children of the two younger classes made a box with the cover hinged on with strips of leather; those of the two older, a case with shelves fitting into grooves. The work was divided into steps; each was mastered before the next was tried. All the children began with the use of the ruler in measurements to an eighth of an inch. The try-square came next. As soon as a true line was drawn, the saw was used to divide the board. After the first day no two children were exactly together, each one's position depending on his own results. The third step—the cross-cut saw—detained most of the children several weeks; a true cut with its face at right angles to each

face of the board was required. This the children tested for themselves. Often during the first work with saws a child would ask, "Will that do?" "Test it," was the reply. Reluctantly the child applied the test, and renewed his courage as best he could. After a time the desire to use a new tool and to get on as some other child did gave way to desire for perfection. This brings me to the chief end of the work—not skill in handicraft or any finished products, but to put before the children concrete examples of the true and the false, in such a manner that the child himself should judge his own work by some unvarying standard. As an instance of the moral effects: One of the older boys was the first to finish the shelves and both sides of his case, all but one groove. The excitement of this eminence dizzied him, and that groove was a failure—being too wide, it left an ugly crack above the shelf. No one was more sensitive to that ugliness than he; but the struggle between his desire for perfection and the fancied humiliation of making another side and letting some other child be the first to complete a case went on for some time. Finally, with a manly effort to keep his eyes from overflowing, he laid the faulty side among the failures and began again. To give up the work of many days, and the prospect of coming out ahead, was to win a great battle not for himself alone but for his comrades. For use, the rejected side was almost as good as perfection itself; to ideas of truth and beauty the boy's mind yielded obedience. Such yielding of lower motives to higher ones, such discipline of patience and judgment as these lessons gave, were not reached in any other line of work.

Most public schools for primary children have two sessions a day for ten months; in the experiment there was but one session a day for eight months. In the former, five hours or more a week are spent in reading alone; in the latter, less than five hours a week were given to the science lessons and to the reading drawn from them. The saving of time in other studies was almost equally great; and besides the large body of superior knowledge opened to the children, the ordinary proficiency in all subjects commonly taught in primary schools was generally reached. This demonstrates the fallacy of the current opinion that children can not be taught science, history, and literature, and at the same time master the usual three r's allotted to them.

But the experiment aimed to introduce the child to the world of real learning, with the idea that such introduction would produce certain effects on his mind; and it is by that aim and those effects that it should be judged. As to the former, the reader has but to examine the body of knowledge outlined, and judge whether it is worthy to be called real learning and the foundation of knowledge.

Among the effects, perhaps the chief place should be assigned to the general attitude toward study. Compare two children trained in the two ways. On entering school both are equally eager and happy. One is kept for the most part away from learning, and laboriously taught to hold the empty wrappers of it; the other is taken at once into the shrine, where he soon becomes at home; and, while he gets wrappers as rapidly as the child outside, every one is full and overflowing. The former grows tired of tasteless drudgery and longs to have school days over; in the latter, nearness to the central fires kindles the sacred flame, and its shining through the fleshly covering makes his face a contrast to that of the other child. One finds the school-room a prison; the other an enchanted land where all is "truly true." If both leave school during the first six years—as so many do—the former is likely to have vague notions about a large field of study, and but little interest in its contents or faith in their value; while the latter will be as likely to preserve sympathy with learning, and desire to advance it in himself and others.

Among other effects may be mentioned:

1. The children learned to ask serious questions. In a lesson on clouds and rain, Emma asked, "Why is the rain not salt, if most of the cloud vapor comes from the ocean?" She was told to dissolve a certain amount of salt, to evaporate the solution over a fire, and note results. On the following day she reported that the same amount of salt was left after evaporation as she had first used, and gave as her conclusion that ocean-water in evaporating leaves all its salt behind; and the youngest boy added, "Then only pure water can float up into the blue sky."

2. They learned that opinion without knowledge is folly. In planting a window garden, they put seeds in pots of earth; I, between wet blotting-papers. Their decided opinion was that my seeds would not grow. A week later they were eager to give this sentence, "The seeds in Miss Alling's garden did grow."

3. They became fond of mental activity. They were not marked, formally examined, hurried, nor required to do a certain amount in a definite time. This freedom and leisure transformed their first laborious, timid thinking into a delight, which they entered upon as spontaneously and fearlessly as upon their outdoor physical games.

4. Their habits of thinking improved. At first they showed but a superficial interest in the objects studied, and much questioning was needed to direct and hold their attention; later, they voluntarily seized upon the marked features of objects and phenomena, and pursued them until practically exhausted. We did not flit hither and thither, giving the children new objects of study each day, but kept them at work upon one so long as it

could yield anything within their comprehension. As an instance, successive lessons on the cotton plant were given for three weeks.

5. Their perceptions became almost unerring. At the Museum of the Boston Society of Natural History, one day, Katherine exclaimed as we rapidly passed a case of minerals, "There's some graphite." Turning and seeing whitish specimens, I said, "Oh, no; have you forgotten how graphite looks?" The child insisted, and we turned back to the case. Sure enough, on one shelf the white rocks contained grains and threads of graphite, which fact the child had gathered in one rapid glance.

6. Memory became active and generally true. It was aimed to pursue all things in order, with regard to natural relations and associations; beyond this the cultivation of memory was committed to the qualities of the ideas presented. The result seemed to prove that memory is retentive in proportion to the activity and concentration of the whole consciousness, and that this is proportioned to the interest of the subject-matter.

7. Imagination was vivid and healthy, producing clear reproduction, apt illustration, sometimes witty caricature, and occasionally thought and expression delicate and lovely enough to be worthy the envy of grown-up *literati.*

8. There was a beginning made in the habits of independent examination of any matter, of honestly expressing the results of such examination, and stoutly maintaining one's own ideas until convinced of error, and then of readiness to adopt and defend the new, however opposed to the old. These habits lead to mental rectitude, robustness, and magnanimity, which qualities confer the power of discriminating values: for pride of opinion gives blindness; the love of truth for its own sake, sight.

9. In waiting for Nature to answer questions—sometimes they waited three weeks or more—and in continual contact with her regularity and dependence on conditions, they gained their first dim conceptions of what law means, and of the values of patience and self-control, and of realities as opposed to shams. Finding in Nature mysteries which the wisest have not explained, a half-conscious reverence stole upon them—the beginnings of true spiritual growth.

At first the experiment called forth much criticism. At home the children told about rocks and plants, and related stories from history and literature, but said little about reading and writing. Parents came to see, and universally condemned the method. One mother said, "My daughter will study geology and literature when the proper age comes; I wish her now to learn reading and writing, and have simple lessons in arithmetic and geography." But she yielded to her child's entreaties, and allowed her to be experimented upon. Later, this mother visited the department to

express her wonder and satisfaction at her daughter's progress in reading, writing, and number. A father, after visiting the department, said, "My boy isn't learning anything; he's having a twaddle of experiments." Three months afterward he said, "My boy's whole attitude of mind is changed; he looks at the world with new eyes, and is also progressing rapidly in the studies common to children of his age."

A criticism frequently met was that the vocabulary was too difficult, and, being largely scientific and technical, could not fit children to read children's books. Experience proved the contrary. Reading for ideas, the children were not deterred by a few unfamiliar words. In reading stories in books, they could usually get the principal ideas; and to infer the meaning of the unknown forms had much novelty and interest. It was also objected that the ideas themselves were too difficult, and could not possibly be comprehended by the children. In a language lesson of the second year, Frank gave the sentence, "The soil is thin." A visitor asked, "Did you ever see a well dug?" "Oh, yes; at my grandfather's, last summer." "Was the soil there thick or thin?" "Thick." "How thick?" Looking from floor to ceiling, "Thicker than from this floor to the ceiling." "Then what do you mean by saying that the soil is thin?" was asked in a mocking, disconcerting tone. Frank dropped his eyes in thought; after a moment he said, "I mean it is thin when you think of *all the way down to the center of the earth.*" This boy entered before he was six years old, and was at this time barely seven.

Teachers who visited the department said, "You have a comparatively small number of children from cultivated families; even similar results could not be obtained in the large, miscellaneous public-school classes." This could be met then by the statement only that mind has everywhere the same elemental possibilities, and must yield similar results for the same influences, although the time required might be much lengthened. This criticism has now been answered in part by the results of a trial made in the public schools at Englewood, Ill., an account of which will appear in a subsequent paper.

The few scientists who knew of the experiment looked on with favor. "It is the ideal way," said one. "A realization of my own dreams," said another. An eminent leader in educational affairs in this country objected that the great majority of our primary-school teachers could not follow in the same line because lacking the requisite body of knowledge. When courses of study for lower schools are made out by eminent specialists with a view to putting into the hands of children the beginnings of their own lines of research, and when school authorities provide courses of lectures and other means of furnishing to teachers the necessary

body of knowledge, I think teachers will, as a whole, be quick to respond to the demand and the opportunity—as a release from the belittling effects of their present monotonous drudgery with trivial ideas, if for no higher motive.

In conclusion, the reader may wish to ask, "Was the experiment, after all, a success?" I answer, "As a demonstration of the possibility and value of introducing little children to real learning, yes; as a realization of my ideals, no." I was conscious that there was much that was superficial in the work; and that, in striving to avoid shadows and to grasp the real substance of education, I often grasped but another and a finer sort of shadow. May some other teacher, having greater fitness for the work, and a longer opportunity for effort, reach the goal for which I started! The instruction such an one could give about primary education is needed all over our beloved land.

THE AVIATOR FLYING-MACHINE.

By M. G. TROUVÉ.

A SUCCINCT history was given by M. G. Dary, in a recent number of *L'Électricien*, of the vain efforts that have been made at different times to steer balloons in the atmosphere. Some of the experiments were, indeed, of real merit; but they did not succeed practically, because the problem they were intended to solve offers insurmountable obstacles. The steering of balloons and the realization of great speed with them are practically impossible, and the results obtained from experiments directed to those objects have not been worth the immense outlays that have been made upon them. Yet balloons styled directable will probably render very appreciable services in military art and under a few other special circumstances. The experiments of M. Gaston Tissandier and Commandant Renard have not been useless, and it will be of some advantage to continue them. But while balloonists are right in seeking to increase the dimensions of their globes in order to increase at once the proportion of ascensional power and of motor and propulsive energy to resistance, we, advocates of machines heavier than the air, looking especially to great speed, would gradually diminish the function of the balloon as a sustainer, reduce it, and bring into greater predominance the propulsory organs, making them at once more powerful and lighter. These are those which, with the motor and the generator, represent the element heavier than the air. When the balloon shall have been eliminated in this way, practical aërial navigation will have been accomplished.

Let us suppose ourselves looking through a glass, eye at the eye-piece, at a balloon. It is large, gigantic, monstrous, the aërostat of to-day. Turn the glass, end for end. The balloon is reduced, and becomes a mere point, imperceptible, lost. Such is, from our point of view, the balloon of the morrow. It is well for the present to use the balloon as a supplementary sustaining instrument; but let us always keep in mind that we shall thank it as soon as possible for its services and show it the door. A hypothesis should be to the physicist simply a provisional artifice for the convenient grouping or explaining of a number of determined phenomena; and, to our view, a balloon is a similar artifice, the present uses of which may be valuable.

We had the honor some years ago of becoming acquainted with MM. de la Landelle and Ponton d'Amécourt, warm partisans and advocates of the doctrine of machines heavier than the air, which originated, according to classical traditions, with Architas. They convinced us, and we have since been their fervent disciple. We are, in fact, a persistent admirer of the simple processes employed in Nature and used in a marvelous way by birds to sustain themselves in the air and guide their flight, and specious calculations have never caused us to doubt the possibility of a solution of the problem of locomotion in the air by wholly mechanical means; and we have long regarded the solution of it as depending solely on the discovery of a powerful and light motor. How many examples does the history of natural philosophy present us of calculations that have deceived—either because their starting-point was false, or because we were mistaken in interpreting the results!

What good does it do to descant on the forms and the details of an air-machine when its most essential part, its soul we might say—its motor—has not been found? Could we give a rational theory of telephony before Bell invented his electric telephone, or of the transmission of force to great distances before the creation of the Gramme machine?

We have received numerous letters during the last twenty years from authors and inventors desiring to submit to us their projects and arrangements of propellers. "It is all very well," we have told them, "but, before sending me anything—have you a motor?" "A motor? No, sir; we have thought about it, indeed, but have depended on you for that." "If I had a motor," I would reply, "I should have no need of your apparatus; I have a thousand of them, and my only trouble is in choosing between them." The motor, in fact, is the essential thing; having that, it is a minor affair whether one prefers the aëroplane, the helicopter, or the aviator; it is a question of return—a question that must be looked into, but which is strictly subordinate to the nature of

the motor. It is not till that is got that calculation should come in, when it can find a sure starting-point, based on well-conducted experiments and precise ideas, and its results will be susceptible of an immediate verification. We have constantly employed this prudent, positive method, and it only can give satisfactory results. This motor, which is to fulfill at the same time the two conditions so hard to reconcile, of great power and extreme levity, we shall now try to describe.

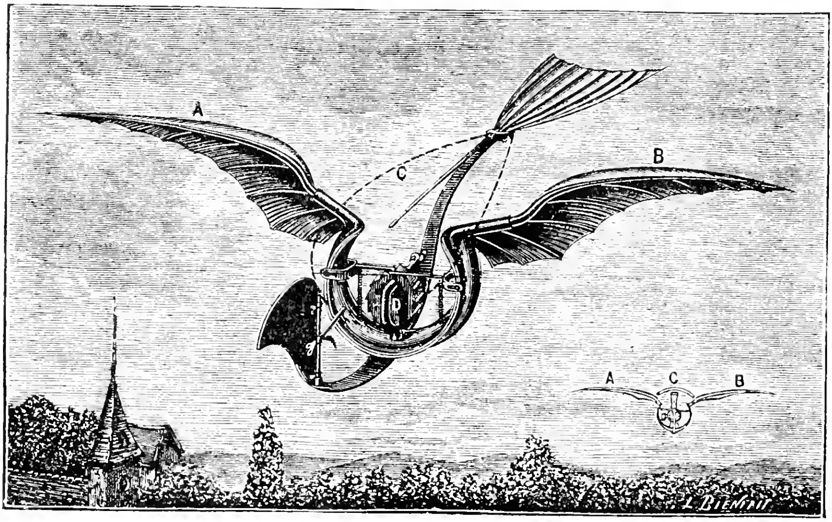


FIG. 1.—BIRD-LIKE GENERATOR-MOTOR AND PROPELLER.

The fact indisputably results from observations, from the positive experiments of M. Marey, from the studies of M. Espitalier, and from our personal labors, that birds expend on an average a motor exertion of 75 kilogrammes per unity of weight—a unity comprehended between 3·6 and 12·5 kilogrammes—in rising vertically one metre per second. Observe that we are talking of gross work, not of useful work effected directly upon the air. Thus Goupil, a respected authority, has found that the work of a horse-power in the pigeon is given for a weight of 12·5 kilogrammes. That is the manifest work, but not the work really developed by the animal; the wing, like the screw, in fact, makes only a weak return.

We select, then, the minimum unity of weight 3·5 kilogrammes per horse-power which results from the experiment with our electrical helicopter, because we know in advance that we can not obtain the full return for the expenditure; and in this weight we must include that of the generator of energy, or of the propeller, and all the accessories.

It is impossible, in this necessarily brief study, to give the

names of all the known motors, and still less of the apparatuses which might be applied as motors. Inventors reserve many surprises in that matter. But, without letting imagination carry us beyond the domain of experimental science, it is allowable for us to consider what satisfaction steam, electricity, and such accumulators of energy as India rubber, steel, compressed air, gas motors, and explosives may give. We are able now, with special precautions, to construct steam motors of extreme levity, and giving one horse-power for a weight very near that of 3·5 kilogrammes; but if we add to them the indispensable generator and the inevitable propeller, the weight increases in formidable proportions, and the system becomes inapplicable to any mode of support in the air.

Electricity, although it is better in many respects, is likewise liable to criticism. Yet we had the honor of performing some satisfactory experiments with it in 1887 at the Scientific Congress in Toulouse, and in 1888 at the Easter session of the *Société de Physique*. We had taken all possible care in the construction of a motor; it was all of aluminum, with the exception of the poles, which were of soft iron. Its weight was ninety grammes, and its power, measured with our dynamometer, was maintained at two kilogrammetres, corresponding exactly with one horse-power per 3·375 kilogrammes. This motor, armed with a light and geometrically perfect helix, made according to a new method which we had explained to the Academy of Sciences on the 12th of July, 1886, was placed in one of the plates of a balance, and put in connection with a constant electrical source of forty watts, when it raised its whole weight. In order to render more visible the extent of the result, and obtain a more exact idea of it, I arranged a light balance with long arms, to one of which I attached the motor experimented on, as in Fig. 2. The electric communications, carried through the foot, knife-edges, and arms of the balance, can not obstruct the freedom of its motion. Being movable in the vertical and horizontal directions, the balance changes immediately from the position A B to that of A′ B′. The power developed by the motor is found, by the most careful measurement, equivalent to two kilogrammes—a power so related to the weight of the motor as to be capable of raising it vertically twenty-two

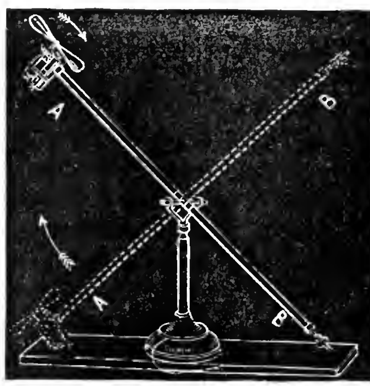


Fig. 2.—Electric Helicopter and Aëroplane.

metres in a second. The simple theoretical calculation deduced from the experimental fact assigns 3·375 kilogrammes to the motor that will develop seventy-five kilogrammes. But so minute a motor returns only about twenty per cent of the energy which is confided to it, while a motor of from fifty to one hundred horse-power will return eighty, ninety, or one hundred per cent. It is possible, therefore, and seems to be reasonable, that a large electric motor, the power of which increases faster than the weight, would employ the surplus of sixty or seventy per cent in raising the generator, the propeller, and the aëronaut. We do not intend to hypothecate the future and form tables on gratuitous suppositions, probable as they may seem. We therefore, for the moment, lay aside the electric motor, because, with its generator and propeller, it exceeds the weight of 3·5 kilogrammes per horse-power, which we have imposed upon ourselves as the minimum.

We now come to accumulators of energy. India rubber, for example, the elasticity of which is often utilized as a reservoir of power, and has a potential, in this point of view, fifteen times superior to that of steel, furnishes power and motion together. Joining to it an immediate organ of resistance to the air, we have an apparatus heavier than air. Penaud chose admirably; and one of the first helicopters was formed upon this plan. But, while India rubber stores a large sum of energy, it expends it faster than it obtains it, and can not of itself renew the provision. Penaud had only a small success with it, because the thongs he used were placed and displaced too slowly; and if he had found a means of changing them more rapidly, the considerable charge of his provision would have made him lose the primary advantages of his judicious choice.

Compressed air motors and gas motors enjoy a certain repute which is in many respects deserved; but as they are constructed, they require the assistance of lubricating and refrigerating apparatus which have weight, and are thus excluded for the present from the list of applications for aërial locomotion. So there are no steam motors, or electric motors, or accumulators of energy like India rubber, or steel, or compressed air motors or generators, that fully answer the requirements. None of them, as they are, supply such coexisting conditions of power and levity as are strictly imposed by the nature of the problem. Is it, then, true that there is now no motor with its accessories, the generator and propeller, which can be used at once, or at least improved upon, for the purpose we have in view? The comparative experiments which we have reported, and have verified with our new universal direct-reading dynamometer, which we had the honor of presenting to the Academy on the 23d of June, 1891, seem to attest this. Still, if the generator and propeller, mutually necessary,

are the organs that embarrass us, can we not find some substitute?

The electrical helicopters, with which we have obtained excellent results, seem to offer a special adaptation of the screw to the motor, which, like all electric motors, turns with an excessive velocity—so that one of the organs seems made for the other. We have often been struck, in our electric boats, with the fact that the wake at the stern is hardly perceptible. This is because the helix of our steering motor-propeller, having the great velocity of twenty-four hundred turns in a minute, enters the water as a screw its tap. In our electric helicopter, likewise, the screw forms, we might say, an integral part of the motor, thus supplying us with a motor-propeller. India rubber offers a still more perfect connection between the accumulator of potential and the motor—the generator or accumulator and the motor being absolutely identical. India rubber is a generator-motor. Hence, since we can not eliminate the generator or the propeller from the apparatus we imagine, we will absorb them and fuse them into the motor. We will create a new organism sufficing for itself, and will call it the generator-motor-propeller. We have ourself devised a propeller of this kind, by the aid of the well-known Bourdon tube, an instrument which is the essential part of the Bourdon manometers. Electricity plays in it a part only secondary, but necessary. This apparatus has so far given us satisfaction, and it may be that it will serve for some time as the essential basis of machines heavier than the air.

If the pressure of the gas contained in the tube increases, the tube changes shape, and its elliptical branches tend to spread apart; while, if the pressure is diminished, inverse action takes place, and the branches approach. If, then, we provoke a series of alternate condensations and expansions, or increasing and diminishing pressures, in the interior of the tube, it will go through a series of oscillations, of strong vibrations, capable of being used as a motor force, chiefly and perhaps only in the conditions under which we have placed ourselves. For the purpose of further increasing the energy of the resistance of the tube, and also of diminishing the volume of the chamber in which the explosions are produced, we have inclosed in the interior a similar second tube—an addition which augments the elastic force of the engendered gases, while diminishing the expenditure of combustibles. The whole of the system is represented by Fig. 1, and was presented by us to the Academy of Sciences in December, 1870.

The wings A and B are fixed directly, but with a rotary motion, at the vibrating ends of the tube, suppressing all intermediary organs of transmission by friction or rotation. Depression of the wings corresponds to condensed pressures, and elevation to dilated

pressures. The chemical combination made use of is the oxidation of hydrogen. Hydrogen is easily obtained, rapidly, in great quantities, and pure, and oxygen for burning it is already prepared in the atmosphere. Our bird, like the birds of Nature, therefore draws a considerable part of its food from the atmosphere. The detonating mixture is regulated at will, but it is nearly twenty-five parts of hydrogen to seventy-five parts of atmospheric air, while the inflammation of it is produced by electricity, as in gas machines. In the small model (Fig. 1) the generator of explosions is a revolver barrel (D), armed with twelve cartridges, the charge of which has been carefully determined; to make the catches perform and the barrel turn, the bird must be left to itself, while the cock is kept raised simply by the weight of the apparatus. To start the machine, it is suspended by a cord fixed at the end of a crane (Fig. 3), while the pendulum thus composed

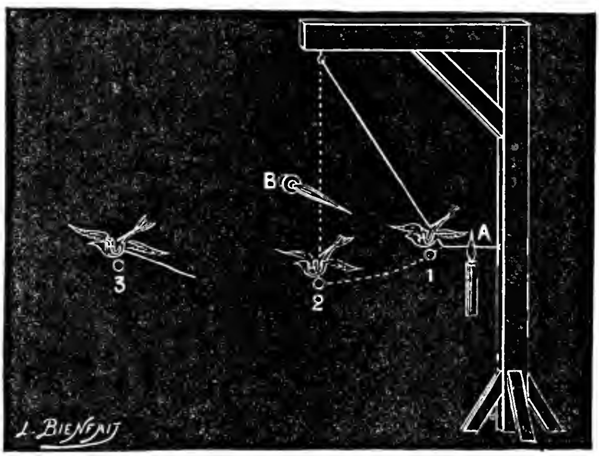


Fig. 3.—Arrangements for starting the Bird.

is withdrawn from the vertical and held by a second cord against the foot of the crane. Two candles, one movable (A) and the other fixed (B), placed in the verticals of the points of attachment, are intended to burn the two cords.

When we burn the first cord with the candle A, the bird, like Foucault's pendulum, begins an oscillation. It goes, describing the arc of a circle, from the position 1 to the position 2, reaching there with a horizontal velocity, when the candle B is applied and burns the suspending cord. The hammer is released and falls, the cartridge explodes, the tube vibrates strongly, and the wings falling sweep the air vigorously; at the same time the bird abandons its first horizontal position, and with its inclined tail takes on a slight movement of ascension (position 3). Thus the disengaged gases escape into the atmosphere, in the inverse direction of the move-

ment, so as to utilize their reaction. The vibrating tube resumes its original shape, and the wings rise. Promptly, the barrel, carried on by its cog-work, brings a cartridge under the hammer, which falls; a second explosion is produced, and the phenomena already described are repeated in their order. During the third, fourth, and so on to the twelfth explosion, the bird flies over a horizontal distance of seventy-five or eighty metres, sustaining itself against gravity and steadily rising. Instead of the bird falling straight down at the end of its course, the wings, kept up by the drawing together of the branches of the tube and the silken aëroplane (C, Fig. 1), the surface of which is proportioned to the weight of the imitation animal, act as a parachute, and the apparatus descends obliquely and slowly. The aëroplane, which is represented by dotted lines, connects the head of the bird with the helm, and with the wings and the tail. The use of the aëroplane will always be of advantage, whatever the power of the motor; for its surface, constantly proportionate to the total weight, will serve to prevent any accident in case of the sudden arrest of the motor machine. We repeat that, in the apparatus of large dimensions, a reservoir of compressed hydrogen is substituted for the cartridges of the small model; while the use of aluminum is suggested by its lightness and the probability of its being obtainable at a reasonable price. We also remark that the extensive cooling surface of the vibrating tube and its direct contact with the air, which will be closer as the velocity is greater, will keep it at a moderate temperature; yet there will be little danger of its getting heated, for the simplicity of the mechanism, and the removal of all transmission by rotation or sliding, will prevent the necessity of using lubricants or refrigerants. In short, the combined advantages of the generator-motor-propeller constitute it the lightest aviator that it is possible to construct. It possesses, we dare say, all the warrantees of ascensional power and return.

We shall be glad if we have succeeded in this summary in conveying to our readers the faith we have in the possibility and the near realization of practical navigation of the air; if the subject has any further interest for them, they will find a general serious and profound discussion of it in a book by M. Barral, and also full descriptions of a number of sustaining machines which we have devised, including the one we have just presented to them. Constructed during the siege of 1870, it is the first machine heavier than the air susceptible of construction on a large scale and capable of traveling by its own force. The crowning experiment in the navigation of the air now depends only on capital and secondary studies; and, again, in centering our efforts on the discovery of a strong and light motor, we believe we were the first (in 1870)

to set forth the problem correctly. We close by saying, with Victor Hugo, "The future is with navigation of the air."—*Translated for The Popular Science Monthly from Le Monde de la Science et de l'Industrie.*

THE POPULATION OF THE EARTH.

AFTER an interval of nine years the publication of the Bevölkerung der Erde has been resumed by the well-known geographical establishment of Perthes of Gotha. This is the eighth issue of this invaluable and authoritative publication. It first appeared in 1872 as a supplement to Petermann's Mitteilungen, the editors being the late Dr. Ernest Behm and Dr. Hermann Wagner, now Professor of Geography in the University of Göttingen. Up to 1882 the Bevölkerung der Erde was issued on an average every two years, always as a supplement to Petermann's Mitteilungen. While the eighth issue was being prepared Dr. Behm died, and Prof. Wagner was not able to undertake by himself the preparation of the vast mass of statistics involved. Owing to various causes, a period of nine years has elapsed before the publication has been resumed. Dr. Wagner's name still appears on the title-page as editor, associated with that of Dr. Supan, who succeeded Dr. Behm as editor of the Mitteilungen, of which the Bevölkerung continues to be a supplement. The form has, however, been changed from a quarto to a large octavo, which makes the work much handier for consultation. It covers two hundred and seventy pages, and is the one work that exhibits in detail the area and population of the earth in all its divisions and subdivisions. It is no mere indiscriminate collection of statistics. The whole is systematically arranged under the great divisions of the globe. Every figure has been critically examined; in all cases the sources of the statistics are given; where there are various figures, the value of each is discussed; where there is no authoritative census, the greatest pains have been taken to obtain trustworthy estimates. Equal care has been bestowed on the calculation of areas, new measurements of a large extent of the earth's surface having been specially undertaken for the work. Thus, it will be seen that Wagner and Supan's Bevölkerung der Erde stands high above all other works of a similar kind. The figures which it gives may be taken as the nearest approximation to the truth obtainable. It may be stated that Prof. Levasseur in 1886–'87 published in the Bulletin of the International Statistical Institute a collection of statistics on the area and population of the countries of the world, which were good and trustworthy so far as they went, though they are not nearly so detailed as those contained in the new issue of the Bevölkerung der Erde.

The preparation of the new issue has involved unusual labor, as it was necessary to examine all the statistics which have appeared since 1882. For many countries which have no censuses Dr. Supan has undertaken special investigations as to population; in this way he has dealt with Africa, Turkey in Europe and Asia, Arabia, China, East India Islands, etc. Dr. Supan is responsible for the sections dealing with Africa, America, Australia, the Oceanic Islands, and the polar regions; all colonial statistics have fallen to his share, while Prof. Wagner has looked after Europe and Asia. In several respects the arrangements of the various sections is an improvement on that of former issues.

In 1866 Behm estimated the population of the earth at 1,350,000,000. In the sixth issue (1880) of the Bevölkerung der Erde the number had apparently grown to 1,456,000,000, showing an ostensible increase of 106,000,000 in fourteen years. But this difference was really due to more accurate statistics and estimates rather than to actual growth. It was somewhat alarming, however, when in the 1882 issue the total population of the earth appeared as 1,434,000,000, showing a seeming decrease in two years of 22,000,000. But this was largely accounted for by the fact that new investigations compelled the reduction of the estimated population of China from 405,000,000 to 350,000,000. The estimate reached in the present issue of 1891 for the total population of the earth is 1,480,000,000, showing an increase of 46,000,000 over the estimate for 1882, being at the rate of 5,750,000 per annum. This estimate is 3,000,000 less than that of Levasseur in 1886, partly due to the fact that Levasseur took higher estimates of the population of China and of Africa than have Wagner and Supan. But as the data for a very large area of the inhabited globe are to a considerable extent based on guesswork, it is no wonder that estimates should differ, and that we can not be sure of the population of the world to within 50,000,000, possibly 100,000,000, either way. In 1880 Prof. Wagner found that, of the total population in that year, precise data based on actual enumeration (censuses or registration) were available for only 626,000,000 out of 1,401,000,000—that is, forty-four per cent of the total. This population has meanwhile increased to 737,000,000 (though the increase in some cases is only apparent); to this must be added 99,000,000, for which, since 1880, exact enumerations have been substituted for vague estimates. This gives 836,000,000 out of the total of 1,480,000,000 of people—i. e., between fifty-six and fifty-seven per cent—of whom fairly precise enumerations have been taken. True, in this is included 113,000,000 (the population of the Russian Empire) of whom a general census, in the modern sense of the term, has not been taken, except in the case of one or two provinces. Although, when the figures are looked at by

themselves, there has apparently been an increase of population since 1880 of 125,000,000, as a matter of fact the difference between the estimated population of 1880 (1,401,000,000, after deducting the excess credited to China) and that of 1891 (1,480,000,000) is only 79,000,000. This apparent decrease in the rate of growth is really due to the reductions which the editors have felt bound to make on the basis of more careful investigations in the estimates of the population of certain regions. Thus, they have reduced the population of Africa by 38,000,000, while in Asia a deduction of 15,000,000 has been effected. All this shows how conscientiously and critically the editors have gone about their laborious task, and leads us to place the more confidence in the results. Even in Europe there are considerable differences between the areas now accepted and those given in previous issues; the population statistics have been changed throughout.

The following table gives the area and population of the great divisions of the earth's surface according to the latest data:

	Square miles.	Population.	To 1 square mile.
Europe *	3,756,860	357,379,000	94
Asia †	17,530,686	825,954,000	47
Africa ‡	11,277,364	163,953,000	14
America #	14,801,402	121,713,000	8
Australia ‖	2,991,442	3,230,000	1
Oceanic Islands	733,120	7,420,000	10
Polar regions	1,730,810	80,400	..
Total	52,821,684	1,479,729,400	..

* Without Iceland, Nova Zembla, Atlantic islands, etc. † Without arctic islands.
‡ Without Madagascar, etc. # Without arctic regions. ‖ The continent and Tasmania.

More recent figures given in the appendix for one or two countries (British India, the Netherlands, etc.) would make no essential difference in the great total. This total is greater by over 12,000,000 than the estimate of Mr. Ravenstein in his recent paper on the Lands of the Globe still Available for European Settlement; but then Mr. Ravenstein reduces the population of Africa by about 30,000,000 below the estimate of Wagner and Supan.

Among European countries Belgium still exceeds all others in density of population; the proportion is 530 persons to a square mile. Belgium is followed by Holland, with 365 to the square mile, and the United Kingdom with 312. If we take England alone we find the density to be close on 480 to the square mile, still considerably below that of Belgium. The density in Scotland is only about one fourth that of England, while that of Ireland is one third. The most thinly populated countries in Europe are Norway and Finland, which have only sixteen people to the square mile. Turkey occupies considerable space in the

new issue, the statistics of the area and population of the various divisions and subdivisions of Turkey in Europe, Asia, and Africa, and of her tributary states, being given in minute detail, with copious references to authorities.

There are some curious and delicate estimates of the area of Europe according to various calculations and within various limits. Thus, according to Strelbitsky (who for several years has been making elaborate calculations and measurements on the subject), the area of Europe is 3,756,545 square miles, while according to Wagner's estimate it is 3,755,493, a difference of about 1,000 miles. But if to this we add Nova Zembla, Cis-Caucasia, and Cis-Uralia, the Marmora Islands, and Iceland, we get, according to Strelbitsky, 3,865,417 square miles, and according to Wagner, 3,865,279, a difference of only 138 miles. Again, if we take Europe within the limits of administrative divisions we obtain an area of 3,836,912, but this includes Iceland, Nova Zembla, the Canaries, and Madeira, making 79,165 square miles. Here comes in the question as to what are the natural boundaries of Europe, a question to which Drs. Wagner and Supan briefly refer. They regard as outside of Europe the Canaries, Madeira, the Azores, and the Marmora Islands. The inclusion or otherwise of Iceland, Spitzbergen, and Nova Zembla, will make a difference of 103,093 square miles; while there will be a further difference of 424,750 square miles depending on the limits adopted for the eastern boundary of Europe. Europe in the narrowest sense, according to these highly competent authorities, covers 3,570,030 square miles. This excludes the polar islands, and draws the boundary of eastern Europe along the crest of the Urals and the line of the Manytch River, thus excluding the Caspian Steppe, but including the Sea of Azoff. By including the polar islands another 103,000 square miles would be added. If the Caspian Steppe be included, the area of Europe would amount to 3,688,792, or with the polar islands to 3,791,792 square miles. If the boundary of eastern Europe be drawn along the Ural crest, the Ural River, and the crest of the Caucasus, we obtain an area of 3,790,504 square miles, or, including Iceland and Nova Zembla (Europe in Strelbitsky's acceptation), the area is 3,866,605 square miles. Finally, taking Europe in the widest sense, including the Ural Mountains, the south slope of the Caucasus, the countries on the east side of the Ural, and the steppe between the Ural River and the Emba, we obtain an area of 3,988,618 square miles, or, with the polar islands, abôut 4,092,000 square miles.

For the section dealing with Asia, Herr B. Trognitz, a land surveyor, has undertaken a new and elaborate calculation of the area of the continent on the basis of the best maps at his command. Into the details of his methods it is unnecessary to

enter; the general result is, that for the continent we are now given an area of 16,021,078 square miles, which may be slightly increased or diminished according as the boundary between Asia and Europe is drawn. To this if we add the area of all the Asiatic islands (exclusive of the new Siberian islands and Wrangel Land), we reach a total area of 17,179,490, the conclusion being that the area of Asia has hitherto been overestimated by 167,570 square miles. The total area of Asiatic Russia, according to Trognitz's calculation, is 6,510,810 square miles, not including the arctic islands. The total area of Persia is estimated at 635,165 square miles, and the estimate of population, according to Houtum-Schindler's calculation for 1882, 7,653,000, is still repeated. But taking into account that during the last nine years there have been no wars and no famines, nothing to check the natural increase of the population, competent authorities believe that the population of Persia is more likely to be about 9,000,000. Although in the body of the work the detailed population of India is only given for 1881, the authors are able, in the appendix, to give that for 1891.

There is an elaborate discussion on the subject of the population of China proper (the eighteen provinces), which at one time was greatly exaggerated, some authorities making it out to be 500,000,000. After a careful examination of all available data, Drs. Wagner and Supan are inclined to estimate the total population for China proper at only 350,000,000 in round numbers, or about 68,000,000 more than the estimate reached by Sir Richard Temple. Including Mantchuria, Mongolia, Kansu, and Thibet, the total population of the Chinese Empire is given as 361,500,000, living on an area of 4,674,420 square miles. Corea is credited with a population of 10,500,000. The total population of Arabia is reduced by Dr. Wagner to 3,472,000, very different from the estimate of 10,725,000 given by Rashid Bey in 1875. The area assigned to Arabia by Wagner and Supan is 1,153,430 square miles.

As might have been expected, considerable space is devoted to Africa, with the result that the population has been reduced to 164,000,000, whereas a few years ago a common estimate was 220,000,000. Drs. Wagner and Supan evidently consider Ravenstein's estimate of 127,000,000 much too low. They say there have been during the past few years four points of "political crystallization"—the Upper Nile, the Niger, the Congo, and South Africa. Mediterranean Africa has, as a whole, remained passive. Here are problems for the future—the fate of Egypt, the Tripoli question, and the Morocco question. A brief sketch of recent events in the partition of Africa is given, with a useful chronology from 1882 to May, 1891. To Africa south of the equator

Herr Trognitz assigns an area of 3,540,740 square miles. Of this, 951,000 square miles are assigned to British South Africa, including Nyassaland and the whole British region from the Zambesi to the Cape. The total population of this area is estimated at only 3,800,000. Neither to the Niger Protectorate nor to the British East Africa Company's sphere do Drs. Wagner and Supan venture to assign either an area or a population. The area, they tell us, is "offen" and for population they simply put a (?). To Portuguese East Africa (Mozambique) an area of 310,000 square miles is given, and Portuguese West Africa, including Portugal's share of Loanda, 517,000 square miles. The Congo Free State is credited with an area of 865,380 square miles, and a population of 14,000,000. Of the total area, 309,000 square miles are under forest.

Turning to America, we find that the Bevölkerung has not been able to secure the figures for Canada for 1891; though as a second part, containing the population of towns, will be issued, no doubt an opportunity will be taken to supplement the information given in this part. Pretty full details are given of the results of the United States census of last year.

About the rest of this invaluable collection of statistics there is nothing further to remark at present. There is a new estimate of the areas of the South American states; indeed, one of the prominent features of the new issue is the care which has been taken in estimating the area of the various states of the world and their administrative divisions. Now that Africa is divided up among European powers, whose officials are spreading all over the continent, it is to be hoped that some means will be taken to form more precise estimates of the population of the various regions. Until that is done we can not know to within millions how many people live upon the face of the earth.—*London Times.*

SKETCH OF ELIAS LOOMIS.

DURING fifty-six years of active life Prof. Loomis made original investigations and contributed valuable additions to our knowledge of terrestrial magnetism, the aurora borealis, meteoric showers, astronomy, and meteorology, and gave to students an excellent series of mathematical text-books. He was connected with four important institutions of learning, of one of which—Yale—Prof. H. A. Newton says his life and work form no mean portion of its wealth.

Elias Loomis was born August 7, 1811, at Willington, Conn., where his father—"a man possessed of considerable scholarship, of positive convictions, and of a willingness to follow at all hazards

wherever truth and duty, as he conceived them, might lead"—was pastor of a church. He grew up inclined to sedentary habits, having a taste for mathematics inherited from his father, and exhibiting a love for the languages at an age so early that he was reading with ease the New Testament in Greek at a period when many bright boys still have hard work with the reading of English. He prepared for college chiefly under the instruction of his father, spending only one winter at the academy, and was examined and admitted to Yale College at the age of fourteen, but waited, on account of his health, another year before taking his place in class. In college he took a good rank in all his studies, without showing a particularly superior proficiency in any one over another. A few weeks before his graduation, in 1830, he entered Mount Hope Institute, near Baltimore, as a teacher. Thence he went, in the fall of 1831, to Andover Theological Seminary as a student for the ministry, but was called from that vocation in May, 1833, to become a tutor in Yale College. He remained in this position till the spring of 1836, when he was appointed Professor of Mathematics and Natural Philosophy in Western Reserve College, Hudson, Ohio. Prior to entering upon the duties of this chair he spent a year in Europe attending the lectures of the distinguished French physicists of the time. He also purchased in London and Paris apparatus for use in his professorship and an outfit for a small observatory. He remained at Hudson—the college and himself being both in straitened financial condition—till 1844, when he became Professor of Mathematics and Natural Philosophy in the University of New York. He then spent one year at Princeton College in the professorship which had been vacated by the resignation of Prof. Joseph Henry to become Secretary of the Smithsonian Institution, then returned to his old place in the University of New York, and continued there till 1860, when he was elected to the professorship in Yale College made vacant by the death of Prof. Olmsted. Here he spent the remainder of his life in active service, teaching, investigating, experimenting, and publishing as long as he was able to work.

For a summary of Prof. Loomis's labors for the increase and extension of knowledge we are indebted to the memorial address of Prof. H. A. Newton, delivered before the President and Fellows of Yale College, in April, 1890, of which what follows is essentially an abridgment.

He had begun his active career before his mind seemed to incline to any one direction of study in preference to another. In childhood he was most ready in Greek; in college he was equally proficient in all his studies; at Andover he led his class in Hebrew; in his tutorship at Yale he taught Latin when he might have had mathematics. The great meteoric shower of 1833 was the sub-

ject of general conversation in the college, and he participated with much interest in the discussions that took place in the Tutors' Club over the views of Prof. Twining and Prof. Olmsted concerning the origin of the mysterious bodies. In the organization of the department committees of the Connecticut Academy of Arts and Sciences, in 1834, Mr. Loomis was assigned to that on mathematics and natural philosophy. From this time on he devoted himself predominantly to those branches of science in which he became distinguished.

He began systematic studies of the earth's magnetism during his tutorship in Yale College, setting up the variation compass of the institution in the north window of his room and making hourly observations of it, usually for seventeen hours of a single day, for thirteen months. The results of these observations—the only published American observations, except some made by Prof. Bache during ten days in 1832, that were made before 1834—were published in Silliman's Journal in 1836. He also undertook the collection of observations of magnetic declination in the United States and the construction of a magnetic chart of the country. This work was published about 1836, and in a revised second edition, with additional observations, two years later. Prof. Bache, comparing Mr. Loomis's results with those obtained by himself sixteen years later under much more favorable circumstances for exact observation and collation, declared that, when proper allowance had been made for secular changes, the agreement was remarkable. The first charts contained but few records of dip; but after removing to Western Reserve College Prof. Loomis undertook, with a dipping needle which he had procured in Europe, systematic observations of this feature. They were continued for several years at seventy stations in thirteen States, and the results were published in successive papers in the Transactions of the American Philosophical Society.

Prof. Loomis's interest in astronomy apparently dates from the meteoric shower of 1833. He read a paper on that subject before the Connecticut Academy of Arts and Sciences in October, 1834, in which he reviewed the concerted observations made by Brandes and his pupils in Germany in 1823, and deduced from them an argument in favor of the cosmic origin of the shooting stars. In November of the same year he made similar observations at New Haven in concert with Prof. Twining who was stationed near West Point, N. Y., the first observations of the kind undertaken in America.

With the new five-inch telescope, the largest then in the country, given to Yale College by Mr. Sheldon Clark, Prof. Olmsted and Mr. Loomis obtained the first sight of Halley's comet on its predicted return in 1835, and observed it throughout its course.

Mr. Loomis, with such means as were at his command, observed its place and computed its orbit. In the same year he computed, from observations of Polaris and of moon culminations, the latitude and longitude of the Athenæum tower—the longitude to within less than two seconds of the best determinations of the present.

In September, 1838, in a small observatory he had constructed at Hudson, Ohio, he began observations with the instruments—a four-inch equatorial, a transit instrument, and an astronomical clock—which he had bought in Europe. They were made upon culminations and occultations of the moon for longitude, on Polaris for latitude, and upon five comets for computations of their orbits. A sixth comet was observed by him at Hudson in 1850. These observations were of much greater relative importance in those small days of astronomy in this country, when the facilities we now enjoy did not exist, than they would be now. While Yale College had a telescope but no observatory, and the Williams College Observatory was used for instruction but not for original work, and while Lieutenant Gillis at Washington, and Mr. Bond at Dorchester, Mass., were only preparing to begin observations in connection with the Wilkes Exploring Expedition, there was, as Prof. Loomis said in his inaugural address at Hudson, in 1838, no place in the United States where astronomical observations were regularly and systematically made. A few years later the first telegraph lines had been set up, and the services of Prof. Loomis and Mr. Sears C. Walker were enlisted by Superintendent Bache, of the Coast Survey, in telegraphic determinations in 1847 and 1848—Prof. Loomis having charge of the end of the line at Jersey City and New York—of the differences of longitude of Washington, Philadelphia, New York, and Cambridge. In the next summer (1849) Prof. Loomis assisted in a similar work to connect Hudson with Eastern stations. These observations were made from three to five years before telegraphic methods were first used in Europe.

Prof. Loomis's interest in meteorology, in which his most important work was done, appears to have begun at about the same time his attention was drawn to magnetism and astronomy. He followed the discussions of the rival theories of Mr. Redfield and Prof. Espy, which began about the time of his graduation, and thenceforward made a particular study of the theory of storms. With a set of meteorological instruments bought in Europe he took complete meteorological observations twice a day at Hudson. The examination of the track of a tornado which passed near that place gave him some light respecting the course of the storm-wind and sharpened his desire to learn more about it. He next undertook the discussion of a large storm—that of

December 20, 1836—concerning which, it occurring on one of the term days which Sir John Herschel had suggested as days for a general system of observations, he was able to collect data from all parts of the United States and some stations in Canada. His discussion of this storm, in a paper read before the American Philosophical Society in March, 1840, was, Prof. Newton says, "probably more complete than that of any previous one, and the methods which he employed were better fitted to elicit the truth than any earlier methods. . . . The results which he was able to secure did not sustain either of the two rival theories, but rather tended to prove some features in each of them." The studies were continued with the examination of the track of a second tornado in February, 1842, which proved to be a part of a general storm, and of another great storm that occurred in the same month. The paper embodying the results of these observations, which was read at the centennial meeting of the American Philosophical Society, in May, 1843, is remarkable for having introduced a new method of investigation. The delineations of storms previous to the composition of this paper had attempted no more than to indicate the progress of the center of minimum pressure by lines drawn from point to point, to which a few lines were added to show certain facts about the movements of the air. "In the discussion of the storms of 1842, instead of the line of minimum depression of the barometer, Prof. Loomis drew on the map a series of lines of equal barometric pressure, or rather of equal deviations from the normal average pressure for each place. A series of maps representing the storm at successive intervals of twelve hours were thus constructed, upon each of which was drawn a line through all places where the barometer stood at its normal or average height. A second line was drawn through all places where the barometer stood two tenths of an inch below the normal," etc.; and also for places where the barometer stood above its normal height. "The deviations of the barometric pressure from the normal were thus made prominent, and all other phenomena of the storm were regarded as related to those barometric lines. A series of colors represented respectively the places where the sky was clear, where the sky was overcast, and where rain or snow was falling. A series of lines represented the places at which the temperature was at the normal, or was 10°, 20°, or 30° above the normal or below the normal. Arrows of proper direction and length represented the direction and intensity of the winds at the different stations. These successive maps for the three or four days of the storm furnished to the eye all its phenomena in a simple and most effective manner." The introduction of this method, which is the prototype, still but little improved upon, of the weather charts now in general use, is

regarded by Prof. Newton as perhaps the greatest of the services which Prof. Loomis rendered to science. The author expressed the opinion in his memoir that "if the course of investigations adopted with respect to the two storms of February, 1842, was systematically pursued we should soon have some settled principles in meteorology. If we could be furnished with two meteorological charts of the United States daily for one year—charts showing the state of the barometer, thermometer, winds, sky, etc., for every part of the country—it would settle forever the laws of storms. No false theory could stand against such an array of testimony. Such a set of maps would be worth more than all which has been hitherto done in meteorology. . . . A well-arranged system of observations spread over the country would accomplish more in one year than observations at a few isolated posts, however accurate and complete, continued till the end of time." Prof. Loomis suggested that the American Philosophical Society should undertake the supervision of such a work, for which local observers would not be wanting. The idea was seconded by Professors Bache and Peirce. The Academy of Sciences at Boston appointed a committee, of which Prof. Loomis was a member, to urge the execution of such a plan upon some proper authority. The American Philosophical Society added its voice. Prof. Henry determined to make American meteorology one of the subjects of investigation to be aided by the Smithsonian Institution; and, by his invitation, Prof. Loomis made a detailed report on the scheme, with an outlined plan of research. This plan was adopted in part by the Smithsonian Institution, but a more perfect organization of observations was needed than the institution could then command before it could reach the perfection of the present system.

In connection with a rediscussion of the storm of 1836, which Prof. Loomis undertook in 1854, he collected a series of observations made in Europe of a storm that occurred there about a week later than the one under review; but, instead of tracing a connection between them, he found that they were distinct, and that the laws of American and European storms did not agree in all cases.

Another subject in which Prof. Loomis was interested, and which stood in relation with his researches in terrestrial magnetism, was that of the aurora borealis. He collected the accounts from North America, Europe, Asia, and even the Southern Hemisphere, of the great display of August and September, 1859; and, comparing them with such facts as he could gather about other auroras, he deduced many conclusions which have since been confirmed in their essential features concerning the relations of the aurora and electricity, magnetism, light, heat, and sun-spots;

the movement of the auroral display and its correspondence with magnetic movements on the earth; the velocity of the auroral wave; the distribution of auroras over the earth's surface; their occurrence in the Southern Hemisphere; their periodicity; and other points, with the discussion of which the world has since become familiar. In these investigations and in those on other subjects Prof. Loomis was ever intent, Prof. Newton says, upon answering the questions, What are the laws of Nature? What do the phenomena teach us? "To establish laws which had been already formulated by others, but which still needed confirmation, was to him equally important with the formulation and proof of laws entirely new."

Prof. Loomis was a prolific writer. The list of his books and papers comprises one hundred and sixty-four titles upon every topic of the sciences in which he was especially interested with which he came in contact, recording the results of his experiments and their different stages. What are perhaps his most important papers were the series of Contributions to Meteorology which, beginning in April, 1874, he communicated twice a year to the National Academy of Sciences, and afterward to the American Journal of Science, in which they furnished the leading articles in eighteen volumes. In them were discussed the results of the Signal-Service observations and the subjects of European publications in meteorology. A revision of the papers was begun in 1884, on which he labored for the rest of his life, and was given to the public in three chapters, the third chapter, discussing the theory of storms, appearing in 1889. In connection with his college lectures on meteorology he published a treatise on the subject in 1868, which, "notwithstanding the rapid advances of the science during more than twenty years, is still indispensable to the student of meteorology." He published in 1850 a volume on The Recent Progress of Astronomy, especially in the United States, which went through two editions, and was then rewritten and enlarged. It was followed by the Introduction to Practical Astronomy and by popular articles in periodicals. During his connection with the University of New York he prepared a series of text-books in mathematics. The series comprised nearly twenty volumes on the subjects from arithmetic up, and, being well adapted to the requirements of teachers, has proved highly useful and successful. Not in the line of science, but a work of industry useful and interesting to all concerned, is the Loomis Genealogy, for which he made inquiries on each of his four visits to Europe, and entered into personal correspondence with every family of Loomis in the United States of which he could hear, and which grew till it contained the names of 8,686 descendants in the male and 19,000 in the female line, of Joseph Loomis, the

first American ancestor, who settled in Windsor, Conn., in 1639. Other subjects than those already specified, mentioned by Prof. Newton as those on which Prof. Loomis made experiments and published papers, were the phenomena of optical moving figures; the vibrations sent out from waterfalls as the water flows over certain dams; the orbits of the satellites of Uranus; the temperature of the planets; the variations of light of the stars η Argus and Algol; and the comet of 1861.

A striking illustration of the value of Prof. Loomis's improvement in the construction of weather maps is cited by Prof. Newton as among his recollections of conversations with Sir George Airy and Le Verrier. The former, before Prof. Loomis's maps were published, expressed himself as having little hope for the progress of meteorology in the shape in which the data then appeared. Le Verrier, exhibiting, in 1869, charts made like those of Prof. Loomis, said: "I care not for the mass of observations made in the usual form; what I want is the power and material for making such charts as these."

A description of Prof. Loomis's characteristics as a teacher is given by a biographer in the Phrenological Journal, who says: "He was a man of quick impressions and very solid convictions. A really kind man, but so strict in his views of propriety and duty that the student, as a rule, regarded him as severe. We remember him well as he appeared in the lecture-room of the university, always calm and even-toned, strict in his demands upon students who might be reciting, very brief in question, a mere trace of a smile if the student acquitted himself well, and nothing more than 'Sit down' when a student showed his ignorance of the lesson by his blundering. He was never sarcastic, never censorious. There might be a coldness of manner and a slight sharpness in his tone when annoyed, but these were passing cloudlets, so to speak, in the calm blue of his manner. He awed the frisky, mischievous ones into quiet, even well-behaved young men while they were under his penetrating eye, so that we never knew of a single instance of insubordination in his room during our course." In a description in general harmony with this, Prof. Newton includes an acknowledgment that was made by Chief-Justice Waite, that "if I have been successful in life, I owe that success to the influence of tutor Loomis more than to any other cause whatever."

CORRESPONDENCE.

THE PROGRESS OF THE SILVER QUESTION.

Editor Popular Science Monthly:

SIR: In your issue of July, 1891, the writer ventured to predict, as "a coming solution of the currency question," that a "gold clause," requiring payment of indebtedness in "gold coin of the United States of the present standard of weight and fineness," instead of silver, copper or fiat money, would be inserted in future long-time mortgages, and that (the legal validity of such clauses being unquestioned) the effect would be to decrease very greatly the then existing pressure for a depreciation of the currency. For it would become a matter of the greatest importance to any one who had obligated himself to pay in gold that no disturbance of the currency should take place which would prevent him from doing so. Various instances of importance, such as railroad mortgages, were pointed out in which financial caution had already resorted to this expedient.

It is interesting to note that this change is taking place every day. Quoting from The Honest Dollar of October 31, 1891:

"Inquiries which we have made of the most prominent companies interested in the negotiating of Western farm mortgages have been met with the invariable answer that all mortgages now placed have a clause inserted that payment shall be made in the gold coin. We have examined numerous bonds representing these mortgages, and in every case the provision that payment is to be made in gold is inserted, and thus not only respecting the principal, but also the interest, the gold clause being written or stamped upon all the coupons. This applies not only to Kansas, but to all Western and Southern States in which the farm-mortgage business has assumed large proportions. It is probable that few farmers have seriously considered the effect of this clause, and, in fact, many of them are doubtless not aware of its presence in their mortgages. Yet the matter is of immense importance to them.

"Let us consider the effect of a gold clause in connection with the theories of the silver men and their opponents, and let us take in first the statement of the silver men that the free coinage of silver would not put gold at a premium. Let us suppose, in other words, that after free coinage had been introduced the silver and gold dollars still remain of equal value. In this case the farmer has gained nothing by the free coinage of silver, and is not affected by it except in so far as all the members of the community may be benefited or injured by the change. But suppose, on the other hand, that the opinions of the anti-free-silver men are right, what is then the position of the farmer? According to this supposition the gold dollars will disappear from circulation, and be worth a premium of, say, thirty-three and a half per cent. But it is in these gold dollars that the farmer must pay his mortgage and the interest thereon—that is, he must pay in the current money one third more than the face of his mortgage. It is easy to see what this means. It means that many a farmer who is comfortably off will find himself very hard pressed, and that those who now find it hard to make the two ends meet will be utterly ruined. And this will be true even if the farmer gets somewhat more dollars for his crops, for he will not get enough more to make up for this difference, and the balance of loss will be enough to make the farmer's lot a direfully hard one. No doubt the silver men tell the farmer that the gold clause in his mortgage does not mean anything. But the meaning of the clause is perfectly clear in common sense and common justice, and a properly drawn gold clause has been held valid by the Supreme Court of the United States, from which there is no appeal. The gold clause, moreover, is part of a contract protected by the Constitution of the United States, and no State Legislature can impair its validity."

Thus the financial world is usurping the functions of statesmanship, and preparing for itself a solution of the most dangerous problem confronting this nation. In the course of a few years the great majority of long-time borrowers will be on paper having in it the gold clause, and will be aware of the fact that their chances of payment depend largely upon the maintenance of the gold standard. The political force of the movement for a cheap currency will thus be largely removed.

But there remains the law of 1890, under which 4,500,000 ounces of silver must be purchased monthly by the Secretary of the Treasury and silver certificates issued for the same. The Government buys 371¼ grains of pure silver for seventy cents and issues for it a certificate for one dollar in silver; or, what is the same thing, it buys 530 grains of silver for one dollar and issues a certificate for 371¼ grains of this as legal tender for one dollar. The force that sustains these certificates, and the silver dollars of which they are equivalents, in the market as the equivalent of the gold dollar, is the same as that which makes one tenth of a cent's worth of copper pass as one cent, or one cent's worth of nickel pass as five cents. *It is their convenience as subsidiary coin*, the impossibility of getting any other, *and the limited number in circulation.* Were the

coinage of copper free, everybody owing a dollar would buy ten cents' worth of copper, have it coined, and pay his debts with it. In this way a man owing $1,000 could pay up with $100, and pocket $900. Were the coinage of nickel free, and legal tender for the same unlimited in amount, he would buy $200 worth of nickel, pay off $1,000 of debt, and pocket $800 profit. The same thing, with diminished ratio of profit, might be looked for with the free coinage of silver.

Now the question is, How long can the Treasury issue certificates for silver without destroying the force which keeps it on a parity with gold? This depends on the amount of necessity there is for currency. The moment that the daily pressure of currency is such that a considerable portion may be conveniently withdrawn and held in safe-deposit boxes, or sent to Europe, that portion will without doubt be gold. If, then, 550,000,000 silver dollars or certificates should be suddenly put forth (that being approximately the amount of gold in circulation), gold would no doubt disappear, because business transactions are adjusted to the existing amount of currency, and the surplus amount thus made would be unavailable here, at least to a large extent. Now, how long can the silver certificates be issued without a corresponding result? Several facts are required to answer this question: 1. How great is the natural expansion of the demand for money per month? 2. How great must be the preponderance of silver before gold is hoarded in quantity? 3. When the hoarding begins, will it accelerate, from alarm or panic?

Without trying to answer these questions, upon which the best informed differ widely, it may be granted that there *is* danger in the continued issuance of so large an amount of currency based upon silver. Assuming this to be a fact, what is the probability of a modification of the law? The opponents of silver having failed for twelve years to repeal the Bland law, will they be more successful with the Sherman law?

Upon this point I hazard the suggestion that the silver movement, which seemed so dangerous a year ago, may have been a blessing in disguise. It led directly to the insertion of the gold clause in contracts, as before stated, with all the consequent effects. It led to the division of the Democratic party; to the justly famous silver letter of ex-President Cleveland; to the defeat of Governor Campbell in Ohio; and to the necessity of choosing an Eastern man, or one opposed to any form of fiat money, for the presidential nominee of the Democratic party. Thus the recoil from the silver agitation has far exceeded in importance of effect the original momentum. The continuous effect of the "gold clause" goes marching on to an irresistible issue in a stable single standard; and it would not be surprising if the final result of the silver movement of the past year would be the relief of the country from the dangers of the compromise law made in the fury of the recent silver agitation.

CHARLES S. ASHLEY.

COLORS OF NAMES.

Editor Popular Science Monthly:

SIR: An article in a recent number of The Popular Science Monthly, by President D. S. Jordan, on The Colors of Letters, assigning colors more or less pronounced to the different letters of the alphabet, reminds me of a childish fancy of my own, of which I have often thought, but to which I had never before attached any significance. The days of the week were as distinctly marked or colored in my early conception as the objects about me. Sunday was red; Monday a light pink; Tuesday gray, with irregular streaks of a darker hue; Wednesday was green, with interstices of a dull white; Thursday was yellow, but not of deep tone; Friday was pink again, and of deeper tinge than Monday; and Saturday was green. What is there in these names to suggest colors? The associations of the days do not seem to offer any explanation, with possibly one or two exceptions, and, if it be a mere freak of imagination, it would be interesting to know the experience of others touching the same matter. Again, as I think over the names of the months and the seasons now, there is a suggestion of color in each, but more, I think, the result of association than in the days of the week.

J. H. CHAPIN.

ST. LAWRENCE UNIVERSITY, CANTON, N. Y., *November*, 1891.

EDITOR'S TABLE.

EVOLUTION AND ITS ASSAILANTS.

THE doctrine of evolution teaches that the changes which take place in the universe both of mind and matter follow an orderly sequence, and that each preceding stage potentially contains the succeeding one—that every succeeding change can only be explained and understood through a comprehension of the preceding one. It incites us, therefore, to a study of cause and effect, and encourages us to believe in the possibility of a rational interpretation of Nature. Strictly speaking, evolution is nothing more than a generalization of the idea of cause. Every man within

certain limits is an evolutionist, and we have little hesitation in saying that the limits within which each man is an evolutionist are the real limits of his intelligence. Where he ceases to be an evolutionist he resigns all attempt to comprehend, and merely records his acceptance of unexplained facts. In the sphere of human history the principle of evolution seems to be fully recognized. The historian who would fold his hands and turn up his eyes before any given event, and say that it was utterly incomprehensible, having no relation, save the abstract one of time, to previous or subsequent events, would be scorned by every intelligent reader. Not to be able fully to explain a historical occurrence is one thing; to say that it has no dependence on previous conditions is another and very different thing. We look to the historian to attack such problems with a view to bringing them under the operation of some law of historical development; in other words, we believe fully in evolution as applied to the social and political history of mankind.

Similarly we believe—and when we say "we" we mean all persons with any pretensions to education or intelligence—in evolution as applied to the physical history of our globe. We believe that it passed through successive stages or phases, each of which prepared the way for the one following. "Evolution," says Prof. Le Conte, "is the central idea of geology. It is this idea alone which makes geology a distinct science. This is the cohesive principle which unites and gives cohesion to all the scattered facts of geology; which cements what would otherwise be a mere incoherent pile of rubbish into a solid and substantial edifice." * That the Silurian age passed naturally into the Devonian, which served as a transition to the Carboniferous, no one who has given any thought to the subject for a moment doubts. The trouble arises when it is proposed to consider successive animal species as genetically connected. The scientific world at large has no difficulty in framing the conception or in adopting the idea, but to a few scientific men and a multitude of non-scientific persons there is impiety in the suggestion that one animal species —or one plant species, for that matter—could possibly have passed into or given birth to another. The creation of species was an office which their theology had reserved for a supernatural being, and they can not assign to natural causes or processes the honor of introducing to existence so much as the tiniest parasite. Whatever is most hideous, uncouth, destructive, and loathsome in the animal kingdom must be regarded as the special and intentional production of Divine Wisdom no less than the noblest forms of life. None the less do men set themselves to destroy whatever in creation they find hurtful or inconvenient; in practically dealing with plants and animals they ask—not, "Did Divine Wisdom create it for a wise purpose?" but, "Does it suit our interests to allow it to exist?"

The great weakness of the assailants of evolution is that they do not offer so much as the germ of an instructive or helpful idea in the place of that which they oppose and would fain subvert. Admitting that there has been much of error in connection with the speculations of the evolutionist school, the error, we contend, has been of a healthful kind. An ancient Greek philosopher held that what was of chief importance in a scientific theory was, not that it should be in exact accordance with facts, but that it should be based on belief in a natural sequence of phenomena. Anything, he said, rather than the non-natural, the irrational, the arbitrary—in a word, anything rather than superstition. And he was right; for the man who is taught to believe in natural causes, studies natural causes; and if,

* Elements of Geology, p. 405.

at a given moment, he attributes to them wrong effects, his further observations will in due time cure him of his error. Thus the errors of the evolutionists are sure to be discovered and corrected, for they consist, and can consist, only in wrong suppositions as to the relations between material phenomena—phenomena which are open to the study of all, and which have no habit of hiding themselves behind a veil of mystery. But what remedy is there for the errors of superstition? What can we say to the man who believes in the uncaused, to whom the universe is full of facts that bear on them no stamp save that of arbitrary will? His superstition is a pillar round which reason will chase him in vain.

To say that every vegetable and animal species is the special result of a distinct divine fiat is to put a veto upon all scientific inquiry in the region of biology. But to-day such a veto comes too late. The world has learned too much under the guidance of the doctrine of evolution, too many regions of knowledge have been fertilized by it, too many individual minds have found in it a never-failing spring of instruction and intellectual stimulation, for any overthrow, or even any obscuration, of the idea to be possible. What, we ask, have its opponents to teach? They are compelled to recognize the general principle of evolution in history, geology, and many other fields of research, and, so far as they do, their intelligence has free scope. But what do they teach instead of it in the field of biology? Absolutely nothing. They simply draw a line and say, "Here begin wonder, miracle, mystery, all that is arbitrary and thought-confounding." To the opponent of evolution the resemblances, analogies, and homologies that run through animated nature are simply so many false lights, *ignes fatui*, suggesting community of origin where community of origin there is none. Rudimentary organs signify nothing, neither do the facts of embryology. All that can be said is that God made things as they are, rudimentary organs and all, just as suited himself. If different species and genera show resemblances, it is simply because the same ideas kept running through the Divine Mind. Such is the sum and substance of anti-evolutionist teaching. That it is anti-scientific, and that it tends to nothing less than paralysis of the intellectual powers, is evident at a glance. Fortunately, it is confined nowadays to synods and conferences, and even there is not received with entire favor. At the recent Œcumenical gathering of Methodists at Washington an earnest divine from the Southern States found some of his brethren, particularly those from England, badly infected with evolutionary ideas. A similar discovery might be made in almost any similar assembly to-day. Evolutionists may therefore proceed very contentedly with their studies. They are in the right path, because they believe in the universality of natural causation; and, if they fall into error, they will work their way out again without any abandonment of their cardinal principle.

LITERARY NOTICES.

The History of Human Marriage. By Edward Westermarck. London and New York: Macmillan & Co. Pp. 644. Price, $4.

The words of Pope—"The noblest study of mankind is man"—long used as a motto by the cultivators of the so-called humanities, are in full agreement with the disposition of scientific research to give increasing attention to the field of anthropology. Folk lore, family and tribal customs, the evolution of religions, the origin and development of races, heredity, etc., are pre-eminently the scientific topics of the time. The many who are interested in this department of science will welcome the work of Dr. Westermarck, concerning which A. R. Wallace says in an introductory note, "I have seldom read a more thorough or a more philosophic discussion of some of the most difficult and at the

same time interesting problems of anthropology." The author defines marriage as a more or less durable connection between male and female, lasting till after the birth of the offspring. The lowest animals among which traces of such a connection are found are the turtles. With the birds it is an almost universal institution, while among the mammals it is restricted to certain species. In the lower animals reproduction is timed with reference to the season of plentiful food-supply, and, as there are seasons of plenty and scarcity of the food of man, the author believes that in primitive times there was a human pairing season. Some of the lowest races actually have such a season at the present time, and certain peoples of a little higher grade have yearly nuptial festivals, while in civilized countries it has been found that more children were born at one or two periods in the year than at other times. The view that primitive men and women lived in promiscuous sexual relations is opposed by Dr. Westermarck, who sees no ground for this hypothesis in the customs of uncivilized tribes of the present time. Passing on to the mode of contracting marriage, the author gives a wealth of information concerning customs of courtship among various peoples and also concerning the related subjects of means of attraction and the liberty of choice. By a chapter on sexual selection among animals he leads up to a consideration of the same process in the human species, his treatment of this subject being one of the points to which Mr. Wallace calls especial attention in the introduction The author maintains that man in the choice of a mate prefers the best representatives of his particular race because a full development of racial characters indicates health, while a deviation from them indicates disease. The production of the instinct which esteems beauty above ugliness is ascribed to natural selection. "According to Mr. Darwin," says Dr. Westermarck, "racial differences are due to the different standards of beauty, whereas, according to the theory here indicated, the different standards of beauty are due to racial differences." The prohibition of marriage between kindred is almost universal, but, as our author shows, all sorts of differences exist as to the unions that are regarded as incestuous by different peoples. His study of this matter has brought him to the conclusion that it is not the relationship but living in the same household that causes the repugnance to marriage between kindred, and that this feeling by no means results from observed bad effects of in-breeding. Among the other subjects examined in this work are marriage by capture and marriage by purchase, marriage-rites, polyandry, polygyny, and divorce. A copious list of authorities quoted and an excellent index are appended. The treatise is marked throughout by evidences of thorough study, clear insight, and sound reasoning.

INTERNATIONAL EDUCATION SERIES, VOLUME XVIII.

A Text-Book in Psychology. By Johann Friedrich Herbart. Translated by Margaret K. Smith. New York: D. Appleton & Co. Pp. 200. Price, $1.

The work of Herbart now presented to English readers in a translation from the revised edition of 1834 is described by the author as "an attempt to found the science of psychology on experience, metaphysics, and mathematics." For a quarter of a century, beginning in 1809, Herbart occupied the chair at the University of Königsberg that had previously been filled by the celebrated Kant. In directing a pedagogical seminary, or normal school, which he founded, he applied philosophy to the art of education. The central thought of the present treatise, as is pointed out by Dr. Harris in the editor's preface, concerns the act of apperception. The book thus constitutes a sequel to the writings of Pestalozzi. For, while Pestalozzianism enforces the importance of perceiving fully and accurately by the senses what is to be learned, the Herbartian pedagogics is occupied mainly with the second step in the learning process—the recognizing of what is perceived as identical with or similar to something that has been perceived before. An impression stored in the mind by a former experience may be out of consciousness at a given moment, but may be brought up into consciousness by some kindred idea. Herbart's theory concerning these phenomena represents ideas as connected in groups, and the forces with which they interact upon each other he represents by mathematical formulas.

The foregoing are among the funda-

mental principles included in the first division of the volume. The second division deals with the so-called mental faculties and with mental conditions, being analytical and descriptive in character. This he calls Empirical Psychology. There is a third part entitled Rational Psychology, treating of the relations between the soul and matter, and giving explanations of various psychological phenomena. "To the mere reader of psychology," says the translator in her introduction, "the Herbartian theories may at first appear peculiar, and in the minds of some may verge upon the absurd; but the careful student will probably find no psychological theories that are so well calculated to stand the test of actual experience."

A Handbook of Industrial Organic Chemistry. By Samuel P. Sadtler. Philadelphia: J. B. Lippincott Co. Pp. 519. Price, $5.

The aim of this work is to give a general view of the various industries based upon the applications of chemistry to the arts. The mode of procedure in dealing with each industry is "first to enumerate and describe the raw materials which serve as the basis of the industrial treatment; second, the processes of manufacture are given in outline and explained; third, the products, both intermediate and final, are characterized and their composition illustrated in many cases by tables of analyses; fourth, the most important analytical tests and methods are given, which seem to be of value either in the control of the processes of manufacture or in determining the purity of the product; and, fifth, the bibliography and statistics of each industry are given, so that an idea of the present development and relative importance of the industry may be had." To assist the reader in following out the chain of operations that converts the raw materials into the various finished products and by-products, a diagram something like a genealogical tree is given in many cases. One such diagram shows at a glance the processes involved in working up beef-tallow, and how much of each product is obtained from the proximate yield of one ox. Another diagram shows how thoroughly the cotton seed is now utilized. Three chapters are devoted to the oils—petroleum, the fats, and the essential oils; the sugar industry is next described; then come the industries of starch and its alteration products, fermentation industries—including the making of alcoholic liquors, vinegar, and bread—milk industries, the utilization of vegetable and animal fibers; the preparation of leather, glue, and gelatin; industries based upon the destructive distillation of wood and coal, the making of dyes, and dyeing. The machinery and apparatus used in each industry are described, and the text is illustrated with one hundred and twenty-seven figures. While the book deals mainly with the chemical changes involved in the industries described, its language has been so chosen that those not specially trained in chemistry can readily understand it. An appendix contains temperature, specific gravity, and alcohol tables, also metric weights and measures.

Stones for Building and Decoration. By George P. Merrill. New York: John Wiley & Sons. Pp. 453. Price, $5.

This work is designed to be of service to all who have to do with the use of stone for constructive purposes. It tells what resources of building-stone are known in each State of the Union, what is the character of each kind and variety, how each works, methods of quarrying and dressing stone, cost, durability, weathering, etc. The book is based on the author's hand-book and catalogue of the collection of building and ornamental stones in the United States National Museum, and some of the matter not contained in that hand-book has been published in various building-journals. The author's experience in preparing the extensive collection above mentioned, as well as its partial duplicate at the American Museum in New York, has afforded him ample opportunity for becoming acquainted with the quarry products of the country at large, while extensive field trips, particularly in the eastern and extreme Western United States, have given him a practical insight into the resources of these regions, as well as some knowledge concerning the usual methods of quarrying and working. The volume is illustrated with views of quarries, figures of tools and machines used in quarrying and working stone, figures showing kinds of finish on stone, and the microscopic structure of certain rocks, etc.

Mind is Matter; or, the Substance of the Soul. By William Hemstreet. New York: Fowler & Wells Co. Pp. 252.

It is impossible to concur with this author even in his presentation of physical truth, and this naturally hinders serious consideration of his views upon such impalpable matters as "astral fluid," "odic force," or "the atomicity of God." His purpose is high and earnest—to win men from grossly material pursuits to a more spiritual life. This he hopes may be realized through his philosophy, that God and the soul are material existences. "God with us—not as a conjecture nor metaphor, but a chemical fact—is all there is of religion." He seeks to establish his theory of soul as a substance "by scientific methods" and with "facts that we all agree about." The most pertinent of these "facts" prove to be the phenomena of personal magnetism and coincidences of thought, in regard to which there is scarcely any agreement of opinion. Other extraordinary assertions are—"force is a *thing* in motion," "all matter is reducible to electric atoms," "electricity or nerve-fluid is the latest discovery in physiology," "every unit of matter must have a sex." The statement is also made that the amœbæ do not eat. The biological truth is that an amœba incloses any vagrant diatom by its pseudopods, ingests it, and assimilates it as actually as higher organisms digest their special food. The amœbæ are even particular in their diet and do not feed upon starch or fat, so that there is no necessity whatever for the "direct conversion of existing atomicity into living things." There is no doubt, "if we could learn by science and philosophy the simple, natural fact that our personal existence is continuous, it would entirely change human life and society," but, speaking scientifically, the "if" exhibits as yet no sign of katabolism.

The History of Commerce in Europe. By H. DeB. Gibbins. London and New York: Macmillan & Co. Pp. 233. Price, 90 cents.

This short work is believed by the author to be the first attempt in English to present a connected account of the progress and development of commerce in Europe from antiquity to the present time. In the space to which the book is limited only the main outlines of the subject could be given, but they are enough to convey an idea of the course of development, and to furnish a sketch which may at some future time be more adequately filled up. The history is given under the three heads of Ancient and Classical Commerce, Mediæval Commerce, and Modern Commerce, the last including the history of the commercial empires in the East and in the West; English commerce in three periods—from the sixteenth to the eighteenth century, the industrial revolution in England and the continental war, and modern English commerce; France and Germany; and Holland, Russia, and the other States of Modern Europe. The commerce of the United States does not properly come within the scope of the work, except as in its relations to the European nations. References are made in several places to the trade with the colonies, and to the later trade with the States. And, under the heading, Recent Developments of Commercial Policy, the "insane example of America" and the "notorious McKinley tariff" are mentioned as patterns which European countries seem inclined to follow; and we are warned that, although we can not understand it, both Europe and the United States may in time discover the fact "that freedom of trade and industry, even though it may seem to encourage foreign competition, is nevertheless of inestimable advantage to the country that adopts it. . . . Meanwhile, both in her colonial policy and in her system of trade and industry, England, though she has yet much to learn, is setting an example to all European nations."

Catalogue of Minerals and Synonyms. By T. Egleston. New York: John Wiley & Sons. Pp. 378.

The author began a catalogue in 1867 for use in arranging the collections of the School of Mines of Columbia College, but was interrupted in the work. When he came to resume it, in 1885, he found that the progress of the science had been so great that the whole had to be done over again from the beginning. The study of mineralogy is embarrassed by the great varieties of synonyms that prevail for the same mineral, whether in different languages or in the works of different authors. The object of the present cat-

alogue appears to be to remedy this difficulty by giving all the synonyms for each species under the head of the authorized English name, and by cross-references. The names of species are printed in capitals, those of doubtful species in Italics, and those of synonyms in ordinary type; and the name of the authority for the species is given, as far as possible, in italics. Well-authenticated species are printed in large capitals; the synonyms follow in alphabetical order; and under species important varieties are printed in small capitals, with their synonyms. The synonyms under each species are divided into classes where that is necessary, and then arranged alphabetically for convenience in referring to them. The symbols representing the composition of the minerals are given according to the new system. The catalogue meets a felt want, for none of the standard works on mineralogy has a complete index.

Intimations of Eternal Life. By Caroline C. Leighton. Boston: Lee & Shepard. Pp. 139.

The worthy aim of this little book as defined in its preface is, "to elicit something clear and trustworthy" in regard to the effect of scientific discovery upon the probabilities of a future life. The author considers that science has been misinterpreted, especially concerning "the existence of God, the reality of the soul and its independence of the physical brain," and she proceeds to liberate it from misconception. The actuality of things unseen is evinced by the invisible rays of light, sounds made audible by the microphone, the phenomena of radiant heat, and molecular motion. The indestructibility of matter and the conservation of energy give reassurance of transformation, while the all-pervading, luminiferous ether "makes the universe seem one and homelike"! Within closer limits two uses are found for this ether: one as material upon which memory impressions may be made; the other, as the substance of the psychic body. Nature hints at continuance in the resurrection of the spring-time, and the fragmentary character of human life implies future completion, which, it is represented, may take place in other worlds than ours. We may yet remain "in the stream of evolution" and find an abiding-place without question of room, for, "if the planets fail us, there are all the hosts of the fixed stars." The nature of death and disposal of the dead are discussed, and cheerful views of our departure from earth are urged. Authorities are given with great impartiality from Prof. Tyndall to the Tonga Islanders, and science, like a veritable Sindbad, is made to sustain a multitude of inferences. Altogether, it must be said, this search for scientific confirmation of the hope of a hereafter is more suggestive than satisfying.

The Metal-Worker Essays on House-heating by Steam, Hot Water, and Hot Air. Arranged by A. O. Kittredge. New York: David Williams. Pp. 288. Price, $2.50.

The essays in this book were prepared in 1888 in answer to an offer of prizes by the periodical, The Metal-Worker, for the best methods of heating a house, plans and elevations of which were given. Three systems of heating—by steam circulation, by hot-water circulation, and by hot air—were recognized in the competitions; and provision was made for the consideration of combination plans. The results of the competition were very successful, both in the number and character of the essays received and the attention they attracted. The essays in this book are reprinted from the journal in which they were first published; and to them are added summaries derived from very careful study of the competitive efforts. The papers are arranged under four different heads, namely: 1. Combination Systems, two essays—one on Steam and Warm Air, and one on Hot Water and Hot Air. 2. Steam-heating Systems, four essays. 3. Hot-water Circulating Systems, three essays. And 4. Hot-air Systems, six essays. The papers indicate wide ranges of practice; and it is believed that, taken altogether, the fifteen essays present a better idea of current practice in house-heating than can be found anywhere else. All the systems proposed are adequately illustrated.

Second Annual Report of the Geological Survey of Texas, 1890. E. T. Dumble, State Geologist. Austin. Pp. cix + 756.

This large volume is devoted mainly to describing the mineral resources of the

State so far as determined during the two years' existence of the survey. In the course of the second year the co-operation of the United States Geological Survey and of the United States Coast and Geodetic Survey were secured in topographical work, much to the advantage of all branches of the work of the State Survey. Several geologists worked during the year at mapping the iron ores of the east Texas district, and the associated clays and lignites were also studied. Prof. Robert T. Hill studied the economic geology of the Cretaceous area, but resigned from the survey without making his report. Prof. W. F. Cummins was engaged in a detailed study of the coal measures of the central coal field; the Guadalupe Mountains were explored by Mr. Tarr; and further work on the mineral resources of central Texas was done by Dr. T. B. Comstock, who discovered tin in this region and obtained much information concerning the deposits of other metals, and of granite and salt. In the trans-Pecos region, Prof. W. H. Streeruwitz, after completing the topographic mapping of an important area, spent the rest of the season in examining the mineral veins of the region. For lack of books and type specimens most of the paleontological work on the Texas rocks has been done outside the State. An offer by the State Geologist to furnish collections of the rocks and minerals of Texas to the high schools of the State brought more applications than could be filled; forty-one sets, more or less complete, were furnished. The details of the year's work are given in the papers accompanying the report of Prof. Dumble, the text being illustrated with maps of the several localities, drawings of sections, and photographic views.

An Introduction to the Mathematical Theory of Electricity and Magnetism. By W. T. A. Emtage. New York: Macmillan & Co. Pp. 228. Price, $1.90.

This work, which appears in the Clarendon Press Series, is adapted to students far enough advanced to possess a knowledge of differential and integral calculus. It is complete in itself, and may be read without previous knowledge of the subject. Purely experimental parts of the subject requiring no special mathematical treatment have been entirely omitted.

Plane and Solid Geometry. By Seth T. Stewart. New York: American Book Company. Pp. 406. Price, $1.12.

Prominent features of this text-book are its strict adherence to the principle of association and its graded exercises. Each book treats of one subject, and each section treats of one subdivision of the subject, so that all relating to the subject or its subdivisions being placed together, the several parts will support one another in memory by the law of association. The same method of arrangement—the resultant form of the book being one that is rendered possible only by the grouping of propositions—favors the regular gradation of exercises. At the end of each section miscellaneous exercises, assorted and graded, are presented in an order intended to promote, by their successive solution, a constant growth in the power of analytic and synthetic thought. A synopsis of each book precedes the book itself, as an encouragement to students to work independently of the demonstrations given in the text. Thus, before giving the definitions of points, lines, and angles, the pupil is set to construct them if we may use the word, after which the definition follows, of necessity; and so on, through the book. The inductive method is in this way employed in the treatment of each part of the work; but, while the approaches to the subject are thereby rendered more agreeable, the author has been conservative in retaining, as far as possible, the usual phraseology of propositions and a wholesome rigor in demonstration. Throughout the volume the diagrams and demonstrations are in full view of each other.

No. 3, Vol. IV, of *The Journal of Morphology*, contains seven papers. The first embodies some *Studies on Cephalopods*, in regard to Cleavage of the Ovum, by *S. Watase*. It is illustrated with four plates and nineteen figures in the text. *J. Playfair McMurrich* has a second installment of his *Contributions on the Morphology of the Actinozoa* in this number, dealing with the Development of the Hexactiniæ. It is accompanied by a plate. There are short papers by *G. Baur* on *Intercalation of Vertebræ*, and by *W. M. Wheeler* on *Neuroblasts in the Arthropod Embryo*. *G. Baur* also contributes a paper on *The Pelvis of*

the Testudinata, with notes on the evolution of the pelvis in general. *Prof. C. O. Whitman* has two papers in this number, one dealing with *Spermatophores as a Means of Hypodermic Impregnation*, the other being a *Description of Clepsine Plana.* Each is accompanied by a plate.

The most extended paper in No. 1 of Vol. V is by *W. B. Scott*, of Princeton, on *The Osteology of Poebrotherium.* This number contains also *A Contribution to the Morphology of the Vertebrate Head, based on a Study of Acanthias vulgaris*, by *Julia B. Platt;* a short paper on the *Reproductive Organs of Diopatra*, by *E. A. Andrews;* the third of Dr. *McMurrich's* series, dealing with *The Phylogeny of the Actinozoa;* and an account of the *Development of the Lesser Peritoneal Cavity in Birds and Mammals*, by *F. Mall.* Plates and small figures accompany the papers.

An address to the New England Cremation Society by its president, Mr. *John Storer Cobb*, has been printed in pamphlet form, with the title *The Torch and the Tomb.* Mr. Cobb cites many instances in which the decomposition of buried bodies has caused disease by polluting water-supplies, by contaminating the air that passes over cemeteries, or by allowing the escape of bacteria into the overlying soil in cases of deaths from infectious disease. He also shows the lack of foundation for the current objections to cremation, and quotes the enthusiastic approval of this process expressed by a clergyman whose prejudice had been completely removed by witnessing the incineration of a friend's remains. The society was organized in January, 1891, and Dr. W. H. Wescott, P. O. box 2,436, Boston, is its general secretary.

The Archæological Institute of America has published *Contributions to the History of the Southwestern Portion of the United States*, by *A. F. Bandelier*, one of the archæologists of the Hemenway Expedition. These papers embody materials derived from the archives of Santa Fé, Santa Clara, El Paso del Norte, and Mexico, together with topographical and archæological data obtained by exploration. A preliminary sketch is given of the knowledge which the Spaniards in Mexico possessed of the countries north of the province of New Galicia previous to the return of Cabeza de Vaca, in 1536. This is followed by four monographs, dealing respectively with the wanderings of De Vaca; Spanish efforts to penetrate to the north of Sinaloa, between 1536 and 1539; Fray Marcos of Nizza; and the expedition of Pedro de Villazur from Santa Fé to the Platte River in 1720. A subscription of one thousand dollars is solicited to complete the final report of Mr. Bandelier on his investigations among the Indians of the Southwest.

The Third Year-book of the Brooklyn Institute, 1890–'91, gives evidence of renewed vigor in this old institution. The book contains lists of officers and members, the by-laws, a brief history of the Institute, and an account of the work of 1890–'91. During the past winter each of the many departments of the Institute provided a lecture once a month, making a large aggregate of such lectures. The library of the Institute comprises 13,000 volumes, and its circulation for the year ending September 1, 1890, was 55,891. A biological laboratory course was carried on during July and August, 1891, at Cold Spring Harbor, Long Island, under the direction of Prof. H. W. Conn. In December, 1888, a movement for the formation of Museums of Art and Science in Brooklyn was initiated by the Institute, and considerable progress has been made in this direction.

The principle of the slide-rule has been applied by Mr. *H. J. Thomas* in the *Slide-Rule Perpetual Calendar* (Jerome-Thomas Co., New York, 25 cents). This calendar can be set for any month of any year, past or future, and old style as well as new style. We note one misprint—29 for 59—in the Year Letter Table.

An essay from the pen of *Edward L. Anderson*, sketching the origin and development of man, has been sent us (R. Clarke & Co., 25 cents). It is untechnical in language and highly finished as to literary style. The author entitles the essay *The Universality of Man's Appearance and Primitive Man*, and affirms his conviction that man "appeared everywhere upon the earth, where the conditions were favorable, during a certain geological period." He also asserts that man has a soul, and that a pure soul is worthy of immortality.

The *Report of the New York Agricultural Experiment Station*, for 1890, records the

beginning of feeding experiments with milch-cows, for which extensive preparations had been made, also feeding experiments with poultry and swine, and tests of various sorghums. Considerable analytical work on a variety of substances had been done by the chemist; the horticulturist reports tests of a number of vegetables and small fruits; the pomologist describes his researches of the year on the grape and the peach; and a variety of operations are embraced in the report of the farm superintendent.

Mr. *James Terry*, of the American Museum of Natural History, New York, has published a monograph on three *Sculptured Anthropoid Ape Heads* found in the valley of the Columbia River. These heads were carved from a dark pumiceous, basaltic rock; and the author regards as the most probable conclusion concerning their origin "either that the animals which these carvings represent once existed in the Columbia Valley, or that, in the remote past, a migration of natives from some region containing these monkeys reached this valley, and left one of the vivid impressions of their former surroundings in these imperishable sculptures." Five artotype plates accompany the text.

A handsomely printed monograph of one hundred and fifty-six quarto pages, entitled *Dynamics of the Sun*, has been published by *J. Woodbridge Davis* (D. Van Nostrand Co., New York). It is a mathematical and theoretical essay dedicated to the astronomers, and they alone will be able to appreciate it.

A Chart of the Metric System, published by the American Metrological Society, contains tables of the measures of length, area, capacity, and weight; definitions of the terms used in the system; equivalents of cubic measures and weights, and exact-sized diagrams of the metre, the metre graduated into decimetres, centimetres, and millimetres: the litre; the cubic centimetre; ten cubic centimetres; one hundred cubic centimetres; the cubic decimetre; and the kilogramme weight; the whole covering a sheet suitable to hang on the wall. On the back are printed facts concerning the metric system; the action of various nations and of the United States adopting or recognizing it; the adaptation of the metric units to various scales of plans; metric equivalents of old units; graphical conversion and official abbreviations; the metric system in government business; its adaptation to the United States land system; metric railway curves; and other information.

The third volume of Dr. *McCook's American Spiders and their Spinning-work* will be ready for delivery in the coming spring. The cost of preparing the numerous engravings and plates has so greatly exceeded the expectations of the author (who is also the publisher) that he feels constrained to raise the price to new subscribers from $30 to $50 the set.

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Bien, H. M. Ben Beor. A Story of the Anti-Messiah. Baltimore: Isaac Friedenwald & Co. Pp. 528.

Bolles, Frank. Land of the Lingering Snow. Houghton, Mifflin & Co. Pp. 230. $1.25.

Brooklyn Ethical Association. Season of 1891–'92. Pp. 50.

The Californian Illustrated Magazine. No. 1, Vol. I. San Francisco. Pp. 114. 25 cents, $3 a year.

Chamberlain, A. F. Modern Languages and Classics in America and Europe since 1880. Toronto, Ont. Pp. 60.

Chambers, George. Pictorial Astronomy. Macmillan & Co. Pp. 268. $1.

Clay, Cassius Marcellus. Oration before the Maumee Valley Historical and Monumental Association. Toledo, O. Pp. 19.

Denton, Prof. J. E. Trap-siphonage and Trap-seal Protection. Concord, N. H. Pp. 56.

Experiments in Physical Science. Pp. 59.

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Gage, Simon Henry. The Microscope and Histology. Ithaca, N. Y. Pp. 96.

George, Henry. The Condition of Labor. An Open Letter to Pope Leo XIII. New York: United States Book Company. Pp. 157. 30 cents.

Gould, George M., M. D. Fifteen Hundred Cases of Refraction (in Eyes). Pp. 36.

Greely, A. W. Temperature Charts by Decades. For the United States and Canada. Washington: Signal Office. Seventy-two Charts.

Griswold, W. M. A Descriptive List of British Novels. Cambridge, Mass. Pp. 200.

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Herbart, Johann Friedrich. A Text-Book in Psychology. New York: D. Appleton & Co. Pp. 200. $1.

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James, Prof. Joseph F. Age of the Point Pleasant (Ohio) Beds. Pp. 10, with Plates.

Keen, W. W., M. D. Compressing the Subclavian

Artery. Pp. 3.—A New Method of Tenotomy. Pp., 5.—Four Operations for Appendicitis. Pp. 6.

Lang, Dr. Arnold. Text-Book of Comparative Anatomy. Macmillan. Pp. 562. $5.50.

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Mackay, John Henry. The Anarchists. Boston: Benjamin R. Tucker. Pp. 305. 50 cents.

Manson, Marsden. The Cause of the Glacial Period, etc. San Francisco. Pp. 21.

Maynard, Mrs. N. C. Was Abraham Lincoln a Spiritualist? Philadelphia: R. C. Hartranft. Pp. 264. $1.50.

Means, James. Manflight. Boston. Pp. 29.

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Mills, Wesley. How to keep a Dog in the City. New York: W. R. Jenkins. Pp. 40. 25 cents.

Missouri Botanical Garden. Announcement concerning Garden Pupils. Pp. 8.

New York Academy of Sciences. Transactions March, April, and May, 1891, and Index to Annals.

Penology, Papers in. Second Series. New York State Reformatory. Pp. 148.

Pick, Dr. E. Method of acquiring the French Language. Syracuse, N. Y.: C. W. Bardeen. Pp. 113. $1.

Pickering, Edward C. Preparation and Discussion of the Draper Catalogue. Cambridge, Mass.: John Wilson & Son. Pp. 192.

Raum, Green B. Report of the Commissioner of Pensions. 1891. Pp. 84.

Ridgway, Robert. Note on Pachyrhamphus Albinucha, Burmeister. Pp. 2.—Two Supposed New Forms of Thamnophilus. P. 1.—Notes on some Birds from the Interior of Honduras. Pp. 5.—On some Costa Rican Birds. Pp. 6.—On the Genus Sittasomus of Swainson. Pp. 4.

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Sage, J. R. Annual Report of Weather and Crop Service of Iowa. Pp. 94.

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Smith, J. Bucknall. Wire: its Manufacture and Uses. New York: John Wiley & Sons. Pp. 347.

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Troy, Daniel S. Molecular Motion in the Radiometer, in Crookes Tubes, etc. New York: N. D. C. Hodges. Pp. 61.

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POPULAR MISCELLANY.

Changes in the Grammar-school Programme.—The Association of Colleges in New England, at its last annual meeting, November 5 and 6, 1891, resolved to recommend for gradual adoption the following changes in the programme of New England grammar schools: 1. The introduction of elementary natural history into the earlier years of the programme as a substantial subject, to be taught by demonstrations and practical exercises rather than from books. 2. The introduction of elementary physics into the later years of the programme as a substantial subject, to be taught by the experimental or laboratory method, and to include exact weighing and measuring by the pupils themselves. 3. The introduction of elementary algebra at an age not later than twelve years. 4. The introduction of elementary plane geometry at an age not later than thirteen years. 5. The offering of opportunity to study French, or German, or Latin, or any two of these languages, from and after the age of ten years. In order to make room in the programme for these new subjects the Association recommends that the time allotted to arithmetic, geography, and English grammar be reduced to whatever extent may be necessary. The Association makes these recommendations in the interest of the public-school system as a whole; but most of them are offered more particularly in the interest of those children whose education is not to be continued beyond the grammar school.

The British Association.—The meeting of the British Association in August at Cardiff does not appear to have been as fully attended or as interesting as some of the preceding meetings. The week was a very rainy one, and that, no doubt, diminished to a considerable extent the number of visitors. The total attendance was about fifteen hundred, or two hundred less than that at the Leeds meeting, which was under the average. But, by virtue of an unusually large accession of life-members, the funds at the disposal of the Association for scientific purposes were almost equal to those available at Leeds. From a scientific point of view, Nature remarks, the meeting may

be said to have come up to a fair average. The presidential address of Dr. Huggins was a learned and able exposition of the spectroscopic and photographic investigation of the sky and of the results accruing from it. The addresses of the presidents of sections were mostly historical or special in character, and lacked the abundance of features of living interest that have marked some of the like addresses in past years. In the Section of Physics and Astronomy Prof. Lodge described his investigations as to the behavior of the ether in the presence of rapidly moving bodies, which, without leading to determinate results, indicated that the ether was not affected by them. A noteworthy paper read in this section was that of Prof. H. A. Newton on The Action exercised by the Planets on the Meteorites of our System. In the Chemical Section Prof. Roberts Austen invoked more attention to the metallurgical branch of the subject, and presented the problems, practical and scientific, with which the metallurgist has to deal. The alloys especially were spoken of as offering a profitable field, and "traces" as possibly having a more important bearing on the properties of the substances in which they are found than has been supposed. The address of Prof. Rupert Jones in the Geological Section related to coal, and showed that further investigation is still desirable in tracing the true origin of the coal-beds, and the ages to which their materials originally belonged. Francis Darwin spoke in the Botanical Section on Growth Curvatures in Plants, and gave the results of his long and minute investigations on the subject. Mr. E. G. Ravenstein presented to the Geographical Section an account of the progress of cartography and a justification of geography as a distinct and profitable branch of inquiry. Some of the most interesting papers read at the meeting were presented in this section by women: an account of her journey to Kilima Njaro, by Mrs. French Sheldon, and Mrs. Bishop's (Miss Isabella Bird) account of her observations in the Bakhtiari country. Prof. Cunningham, in the Section of Economics, stated some problems of high importance in that science; while in the Mechanical Section Mr. Foster Brown's address dealt mainly with details as to recent mechanical inventions; and Prof. Max Müller, in the Section of Anthropology, demonstrated the complexity of the problems of ethnical relationships, and showed that no one class of data, whether of language or physiology, or other, is competent alone for their solution. The next meeting of the Association will be held at Edinburgh, with Sir Archibald Geikie as president, August 3, 1892.

Tests of Paper.—Paper lends itself to many frauds which it is of interest to be able to detect; and it is desirable to know how to measure its principal quality—resistance to tearing. The processes for determining these conditions are very simple. There are also special details with which few are acquainted. Important differences are noted between machine-made and hand-made paper. In machine-made paper the resistance to tearing and the quality of extensibility vary according as the force is exerted lengthwise or crosswise; the difference is in the proportion of two to five. The resistance is greater in the direction of the length, while extensibility is greater in that of the breadth. The differences are explained by the method of making paper by machinery. The veins of fluid running out from the reservoir extend themselves along the metallic network without any real tendency to associate themselves closely with the neighboring veins, while the current lengthens the fibers and felts them in the direction of the length. In hand-making, the paper is homogeneous, equally resistant in both directions—a demonstration of the superiority of hand-work. There is no drawing out and felting in one direction, to the exclusion of the other; but the felting is equally distributed over the whole surface. Machine-made papers can not be stretched much in the direction of their length, for the method of fabrication has already stretched them to near the extreme limit of extension. The simplest means of testing the durability of paper as against the usual mechanical agents of destruction is rubbing it between the hands. After such treatment poor paper is full of cracks and holes, while strong paper simply takes the appearance of leather. The experiment also tells something of the composition of the paper. If much white dust is produced, we know that the paper contains earthy impurities;

if it cracks, that it has been bleached too much. The thickness of paper can be measured by putting a number of leaves together, or by the micrometrical determination of the effect of adding a single leaf to the mass. We may burn the paper and examine the ashes. If they amount to more than three per cent, clay, kaolin, spar, or gypsum has been added to the pulp. When we color paper with an iodine solution, yellow indicates the presence of wood-fiber; brown, of cotton or linen; and the absence of coloration, of cellulose.

Man's Agency in the Extermination of Species.—Extermination is defined in Nature as indicating that in certain parts of the range of a species, whether plant or animal, it has ceased to exist, however abundant it may remain elsewhere; while in other cases, especially if the species have but a limited distribution, it easily becomes equivalent to extirpation. The older school of zoölogists seem hardly to have contemplated the possibility of a whole species having become extinct within the period since man appeared upon earth, or to have supposed that a species could by human efforts be utterly swept away. Thus there was once skepticism about the extinction of the dodo, or, that having been established, about its having existed within the human period. The disappearance of numerous animals, formerly abundant, from the settled parts of our country, affords examples of local extinction; and the fate of the buffalo threatens to furnish an instance of total extinction by the agency of man. Man's agency usually acts indirectly—as by changing the conditions of the country, so as to make them unfavorable to the subsistence of certain animals, rather than directly by killing all the individuals of a species outright. The wolf has defied all efforts, by offering bounties and otherwise, to accomplish its destruction in Europe, except in artificially-built-up Holland, where it never was at home; Denmark, every spot of which is accessible to the hunter; and the United Kingdom, where its forest resorts have been removed. Other instances are the extirpation of the quail in New Zealand by means of fires that were lighted for other purposes; the threatened destruction of other interesting animals of Australia and New Zealand by animals of the weasel kind that were introduced to prey upon the imported rabbits; and the destruction of turkey-buzzards' eggs and petrels in Jamaica by the mongooses that were taken there to make war upon rats; of the *Diablotin* petrel of Dominica by a species of opossum; and the destruction of the *cahows* in the Bermudas, till it is not known now whether the bird exists there. The great *skua*, or "bonxie," disappeared from one of its three breeding-stations in the Shetland Islands several years ago, and has been maintained at the other two only through the vigorous exertions, to repress poachers and preserve it, of the late Dr. Robert Scott and the late Dr. Lawrence Edmondston, respectively. The Zoölogical Society has ordered medals struck in honor of the services these gentlemen rendered to science. Though the reward is posthumous, and goes to the heirs of the well-doers instead of to themselves, the acknowledgment is a fitting one, marks an example, and is an encouragement to the lovers of living nature.

Prof. Wright in the British Association.—Prof. G. F. Wright's paper in the British Association, on The Ice Age of North America and its Connection with the Appearance of Man on that Continent, is spoken of in Nature as a most interesting one. The author said that the glacial deposits, transported from several centers mostly outside the Arctic Circle, and the absence of a polar ice-cap, militated against an astronomical and for a geographical cause of the great cold, particularly as an uplift of the glaciated area was coincident with an important subsidence in Central America. He regarded the so-called "terminal moraine of the second period" as a moraine of retreat due to the first glaciation, and thought that the evidence of forest beds, mainly to the south of the area, indicated local recessions of ice, and not a single great interglacial epoch. Palæolithic remains similar to those of the Somme and Thames have been found in several gravel terraces flanking streams which drain from the glaciated region, and made up of glacier-borne detritus; they are regarded by the author as deposits of the floods which characterized the closing portions of the Glacial period. The recession of the falls of Niagara and St. Anthony

gives an antiquity of not more than ten thousand years to the end of the Glacial epoch—a conclusion supported by the enlargement of post-glacial valleys and the silting up of small post-glacial lakes.

Determination and Cultivation of Bacteria.—Many scores of bacteria, says Prof. John B. Roberts, in an address on the Relation of Bacteria to Practical Surgery, have been, by patient study, differentiated from their fellows, and given distinctive names. Their nomenclature corresponds in classification and arrangement with the nomenclature adopted in different departments of botany. Thus we have the pus-causing chain-coccus (*Streptococcus pyogenes*), so called because it is globular in shape; because it grows with the individual plants attached to each other, or arranged in a row, like a chain of beads on a string; and because it produces pus. In a similar way we have the pus-causing grape-coccus of a golden color (*Staphylococcus pyogenes aureus*). It grows with the individual plants arranged somewhat after the manner of a bunch of grapes, and, when millions of them are collected together, the mass has a golden-yellow hue. The difficulty of investigating these minute forms becomes apparent when it is remembered that under the microscope many of them are identical in appearance, and it is only by observing their growth when they are in a proper soil that they can be distinguished from one another. In certain cases it is difficult to distinguish them by the physical appearance produced during their growth. Then it is only after an animal has been inoculated with them that the individual parasite can be accurately recognized and called by name. It is known, then, by the results which it is capable of producing. Bacteria may also be distinguished by their individual peculiarities of taking certain dyes. The similarity between bacteria and ordinary plants with which florists are familiar is remarkable. Bacteria grow in animal and other albuminous fluids; but it is as essential to them to have a suitable soil as it is for the corn or wheat that the farmer plants in his field. By altering the character of the albuminous fluid in which the micro-organism finds its subsistence, these small plants may be given a vigorous growth, or may be starved to death. The farmer knows that it is impossible for him to grow the same crop year after year in the same field, and he is, therefore, compelled to rotate his crops. So it is with the microscopic plants which we are considering. After a time the culture-field or soil becomes so exhausted of its needed constituents, by the immense number of plants living in it, that it is unfit for their life or development. Then this particular form will no longer thrive; but some other form of bacteria may find in it the properties required for functional activity and may grow vigorously. Again, there are certain bacteria which are so antagonistic to each other that it is impossible to make them grow in company or coexist in the blood of the same individual. An animal inoculated with erysipelas germs can not be successfully inoculated immediately afterward with the germs of malignant pustule. As the horticulturist is able to alter the character of his plants by changing the circumstances under which they live, so can the bacteriologist change the vital properties and activities of bacteria by chemical and other manipulations of the culture-substances in which these organisms grow. The power of bacteria to cause pathological changes may thus be weakened and attenuated; in other words, their functional power for evil is taken from them by alterations in the soil, and *vice versa*.

Properties of Peroxide of Hydrogen.—Peroxide of hydrogen has been a subject of experiment by Dr. B. W. Richardson, chiefly with regard to its medical uses, for more than thirty years. He regards it as a solution—although it may be made to take on the gaseous form—and as consisting of water containing, according to strength, so many atmospheres of oxygen; or as an oxygen atmosphere in solution. It is not, however, a mere mixture, but a peculiar chemical compound. The oxygen can be made to accumulate, volume by volume, until the volume of water can rise to ten, twenty, thirty, and some say even more than a hundred volumes of oxygen, before complete saturation is reached and a volatile body is formed. The combination of the added oxygen in hydrogen peroxide is stable in the presence of some substances, unstable and easily evolved in the

presence of others. Some substances, inorganic or organic, when added to the solution, are neutral; others evolve the oxygen and are themselves unchanged; a third kind evolve the oxygen, and with that some of their own contained oxygen; and a fourth kind absorb the oxygen. Thus, with oxide of iron there is no action; with black oxide of platinum a taper can be lighted from the oxygen thrown off; with permanganate the action is very brisk, and oxygen is thrown off from both substances; and arsenious acid absorbs oxygen from the solution. Dr. Richardson has found peroxide of hydrogen useful in a large number of diseases; among them are consumption, whooping-cough, ulcers and purulent exudation, syphilis, diabetes, anæmia, rheumatism, and others, his experiments with which, and his methods of application, are described in a paper recently read by him before the Medical Society of London.

Origin of Caste.—The origin of caste in India was traced by General T. Dennehy, in the International Oriental Congress, probably to the contact of the Indo-Aryans on their first migration with the uncouth, uncivilized aborigines of the countries which they traversed. The Aryans were even then highly civilized and careful as to personal cleanliness and religious observances, and naturally shrunk against contact with the unwashed aborigines. They were particularly so with regard to food, and hence arose the first manifestations of caste in the exclusion of strangers from their meals. This custom grew with years to be a cherished observance, and what was first a measure of hygienic precaution became an article of religious belief. The later developments of caste corresponded with the guilds of European countries so prevalent in the middle ages. New castes were seen growing up in India as new necessities arose. For example, since the establishment of railroads it had been necessary to find pointsmen (switchmen) and firemen; and these men, being anxious to preserve the emoluments of their posts in their own families, were now actually crystallizing into a new caste. The views expressed by M. C. A. Pret, though differing from these, were not inconsistent with them. He discerned the working of evolution in caste. The Indo-Europeans formed at an early period a social hierarchy which continued in full force long after the language spoken by them had ceased to be a living tongue. The general ignorance prevailing in primitive times necessarily involved the evolution of a priestly or teaching caste—the Brahmins. The necessity of having men always on guard against the attacks and invasions of neighboring races with different tendencies led to the warrior class or caste. These two leading castes represented the two leading principles in the constitution of civilization —the religious and the military. The civil principle, properly so called, did not come into existence till a later period.

Little Annoyances and Health.—Such matters as water supply, sewerage and drainage, streets and pavements, including means of rapid transit, parks, and open spaces, lighting, provisions for the dead and for those affected with contagious disease, and the sale of improper food and drinks, are classed by Dr. John S. Billings, in his address on Public Health and Municipal Government, as variables under municipal control, many of which have a powerful influence on the health of the people. A large part of the discussions as to the best way to arrange and manage them, or as to whether in any particular place at a particular time the municipality is doing its duty with regard to them, turn on sickness and death-rates. It should be borne in mind, however, Dr. Billings adds, that no sharp dividing-line can be drawn between comfort and health; that there are many things—such as noise, dust, offensive odors, rough streets, etc.—the influence of which upon sickness and death-rates it would be at present difficult or impossible to demonstrate, at least to the satisfaction of a court of law, which yet add materially to the burdens of life of those who are subjected to them, and may in some instances turn the scales between life and death. The human body in some diseases may be likened to a heavy railway train going up a very steep grade. If the fire under the boiler can be kept bright and clear, if the fuel and water hold out, and the engineer is skilled and careful to get the benefit of every pound of steam power developed, then the train will just reach the top of the hill, provided there

are no little pebbles on the track. It is always difficult, and usually impossible, to obtain evidence that is satisfactory, from a legal point of view, to prove that the offensive odors from a bone-boiling establishment, or the emanations from a cess-pool, or the water from a polluted well, have produced such a definitely injurious effect upon the health of those within the sphere of their influence as to justify municipal interference with vested rights in property, or the exaction of damage for sickness or death produced by them. This has heretofore been due largely to the want of definite and precise or, in other words, scientific knowledge of the causes of disease and death.

Cyclopean Structures in Oceania.—One reason, said Mr. R. Sterndale, in the International Congress of Orientalists, why the remarkable architectural remains existing in the many islands of the Pacific have attracted relatively little attention is the idea that they are comparatively recent. The early people of the Caroline Islands were builders of Cyclopean towers and pyramids, and are still skillful in building great walls of rude stone. While many islands have been peopled by accidental castaways, the settlement of the great mountain groups was effected by organized migrations of savage navigators fighting their way from land to land, and carrying with them their families and household gods, and the seeds of plants and trees. The copper-colored autochthones of eastern Asia spread in the course of ages to the Caroline groups, and were the progenitors of the Palaos, Barbudos, Hombos, Blancos, and other families of gentle barbarians. They were followed by another exdous of a kindred race, ferocious and pugnacious, and Cyclopean builders on a large scale. Their strong castles, built on steep hills or surrounded by deep trenches, attest the frequency and destructiveness of their wars. The architecture of their temples—immense quadrangular, paved inclosures, surrounded by lofty walls and containing within them terraces, pyramids, artificial caverns and subterranean passages—illustrate their religious earnestness. Some of these structures were mausoleums as well as temples, and are spoken of by the present race of natives as sepulchres of the ancient deities. The author's brother, Mr. Handley Sterndale, had found among the mountain ranges of Upolu an enormous fort, in some places excavated, in others built up at the sides, which led him to a truncated conical structure about twenty feet high and one hundred feet in diameter. The lower tiers of stone were very large and laid in courses, with what seemed to be entrances to the inside in two places. It was probably the center of the village, as many foundations a few feet high were near it. The Samoan natives had no tradition respecting the people that may have inhabited this mountain fastness.

Slavic Marriage Forecasts.—Many curious customs are preserved among the Slavic nations from the olden time. Of these, those relating to marriage forecastings are perhaps of the most peculiar interest. In some districts maidens on Christmas Eve throw rings or melted lead and wax into a vessel full of water, and, while fishing them out, sing old songs, the verses of which foretell, as they catch each object, the peculiarities of their future husbands; or bread and money are mixed with the straw which on Christmas Eve underlies the table-cloth; and the girl who in the dark draws out money is promised a wealthy husband, while she who draws bread must give up that dream. If the counting of an armful of chips, gathered alone and in silence from the wood-house, gives an even number, the girl will find a mate; but if the number be odd she will have to live single. The young people, blindfolded and in the dark, pick from the straw with which the Christmas-Eve supper-tables are strewed for purposes of the divination. The drawing of a green sprig promises a wedding, but of a dry one, long waiting. Wine, beer, and water are placed by a girl between two candles on a table, and she retires to a corner whence she can watch in the looking-glass. If the man who is expected to come at midnight drinks the wine, her married life will be one of wealth; if he drinks the beer, she will enjoy a moderate competency; if the water is chosen, poverty awaits her. If wreaths of flowers thrown into a stream on midsummer eve float undamaged out of sight, the omen is good; but should the wreaths break, or the flowers sink before the watcher, the prospects of her future are

clouded. A maiden throws a wreath of flowers over her head backward against a tree. If the wreath catches and hangs on a branch at the first throw, the thrower will become a bride in the first succeeding year; if at the second throw, the wedding will be in the second year; and so on.

Classification of Glacial Formations.—In the discussion in the International Geological Congress on the Classification of Glacial Formations, Prof. T. C. Chamberlin proposed six classes, namely: Formations produced directly from the action of Pleistocene glaciers; formations produced by the combined action of Pleistocene glaciers and accompanying drainage; formations produced by glacial waters after their issue from Pleistocene glaciers; formations produced by floating ice derived from Pleistocene glaciers; formations produced by shore ice and ice floes, due to low Pleistocene temperature, but independent of glacier action; and formations produced by winds acting on Pleistocene glacial and glacio-fluvial deposits under the peculiar condition of glaciation. In each of these classes subdivisions were proposed. Prof. Albert Gaudry led in the discussion that followed. Dr. Felix Wahnschaffe described the action of glaciers in forming moraines. W J McGee presented a scheme of classification with five general heads: Aqueous, at base-level and above base-level; Glacial, direct and indirect; Aqueo-glacial; Eolic; and Volcanic, direct and indirect.

Origin of Folk-lore Tales.—The value of folk lore is regarded by Mr. E. Sidney Harland as lying in the belief that the traditions alike of our fathers and other nations contain and may be made to yield valuable information concerning the primitive beliefs and practices of mankind, and behind these, concerning the structure and development of the human mind. It is chiefly in tales that the speculative portions of a savage creed take shape. Not a little has been done in this direction since Grimm first showed the remains of ancient heathendom in the stories of his own land. Grimm's method has been more widely applied in recent years by distinguished writers to stories found in every region, and conclusions in regard to the beliefs fundamental to all savage religions have been based in part upon them. Those speculations have not been allowed to pass unchallenged. Literary men have contended that the true origin of folk tales is to be found in India, and that they were originally Buddhist parables sowed broadcast by the Buddhist propaganda. But this theory has been weakened by the discovery of streams of Egyptian and even of Jewish tradition flowing through the tales; and as the area of research widened, it was more and more doubted that folk tales found in the remotest corners of the earth all sprang from one center within a measurable historical period. The anthropological theory attributed the origin of folk tales, as of every other species of tradition, to the constitution of the human mind. A similar environment acting upon the mind would everywhere produce similar results; and it is the variations of the environment which give rise to the stories all presenting perpetual coincidences, and all evolved from a few leading ideas common to the race. The birthplace can not therefore be determined, for no story has any one birthplace. Another theory admits that the foundations of the absurd and impossible tales current all round the globe must be sought in the beliefs of savage tribes about themselves and their surroundings, but denies that the mere fact that a given story is found domesticated among any people is of itself evidence of the beliefs and practices of that people, present or past. Some stories must have been invented once, and once only, and then handed on from man to man, from tribe to tribe, till they had made the circuit of the world. This is the dissemination theory, while the other is the anthropological theory. Mr. Harland sustains the anthropological theory.

Nature of the Ether.—Speaking of the theory and function of the ether, Prof. Nipher said in the American Association that the slowing up of light in space occupied by matter shows that the ether within must be either more dense (as Fresnel believed) or less elastic than that existing in free space. It is certainly very difficult to understand what there can be in the molecules of matter that can increase the den-

sity of an incompressible medium. The experiments of Michelson and Morley show apparently that the ether at the surface of the earth moves with it. It is dragged along as if it were a viscid liquid. The field of a steel magnet is, however, a rotational phenomenon. It is a spin which is maintained permanently without the expenditure of energy. It seems, therefore, that the resistance to shear which shows itself in the adhesion of the ether to the moving earth must be a rigidity due in some way to motion. Other experiments of Michelson and Morley on the motion of light in moving columns of water have been taken as proof that the ether in water is condensed to nine sixteenths of its volume in air. The ether in water certainly behaves as if it were more dense, but it is another matter to say that it is so. It seems improbable. The speaker, after describing what might be a more satisfactory way of making the experiment, said that the question to be settled is whether the ether or any part of it is at rest in space, or does it sweep through the interior of bodies that move through it as wind sweeps through the leaves and branches of a tree.

NOTES.

We mention, on behalf of Mr. Frederick Starr, that the originals of most of the objects illustrated in his articles on Dress and Adornment are in the American Museum of Natural History. The omission of this acknowledgment from the articles was not noticed till it was too late to correct it.

The Programme of Lectures of the Franklin Institute, Philadelphia, provides for thirty lectures, beginning November 2d with a lecture on Japan by Mr. Henry Pettit. Several of the lectures will be upon subjects of travel. For the others, subjects are announced relating to the electrical transmission of power, physical exercise, compressed air power, transmission of explosive phenomena, building-stones, refrigerating machines, and other topics relating to hygiene, metallurgy, applied chemistry, etc. The lecturers are men specially acquainted with the subjects which they will treat.

We have received from F. Gutekunst, 712 Arch Street, Philadelphia, a remarkably fine half-size photograph of the late Joseph Leidy. In distinctness of outline, clearness of expression, delicacy of shading, and general tone, it leaves nothing to be desired.

Certain prehistoric remains near Bellary, in southern India, described by Mr. F. Fawcett in the International Congress of Orientalists, are particularly remarkable by reason of the pictures which are engraved on the rocks in their neighborhood, and which the author adduces many reasons for believing to be prehistoric. A commission was appointed by the Congress to make further investigation of the matter.

A tree-climbing kangaroo from Northern Queensland (*Dendrolagus Muelleri*), new to science, is described by Messrs. Luehman and French. It has a body about two feet long, with a tail exceeding two feet. The disproportion between the fore legs and the hind legs is not nearly so great as in the ordinary kangaroo and the wallaby. The toes are strong and curved, so that it is able to climb tall and straight trees, where it lives on their leaves. The specimen from which the species is described was got from a straight tree, about ninety feet from the ground.

A marsupial mole—*Notoryctes typhlops*—a species absolutely new to science, has been discovered living in the sands and among the porcupine grass of South Australia. It is very rare and has been seen by only a few persons, either white men or natives. Perpetual burrowing seems to be the characteristic feature of its life. It burrows very rapidly, but is not known to occupy permanent burrows. The first specimen was captured by Mr. William Conethard, of the Willowie Pastoral Company, and the description is by Prof. Stirling, of the University of Adelaide.

The Bowlder Committee of the British Association reports that in some districts bowlders are being destroyed so rapidly that many described in former reports have disappeared.

Among the features of the Columbian Exhibition to be opened at Madrid in September, 1892, will be an American historical exposition, which is intended to reproduce the condition of the different countries of the new continent before the arrival of Europeans, at the time of the conquest, and down to the first half of the seventeenth century. It will include all kinds of objects, models, reproductions, plans, etc., relating to the peoples who inhabited America then and to all those who had to do with the navigators.

Mr. Ivan Petroff, special census agent in Alaska, has found six hundred natives on Nunivak Island, where there were supposed to be three hundred. They live, in the absence of white men, in the most primitive style, eating walrus flesh and possessing walrus ivory as their only wealth. Besides a few land otter they do not catch any fur-bearing animals.

In the Congress of German Naturalists and Physicians, Prof. Lehman showed to how great an extent the coarse rye-bread eaten on the lower Rhine is polluted by adulteration. He had procured eighty samples of flour and bread such as are used and sold by the small millers and bakers. All of them were polluted, some to an incredible extent, with earth, excrement of mice, other disgusting but not exactly noxious things, and also with blighted corn, darnel, cockle, and other poisonous seeds. None of the samples were free from cockle, and in some there was more than one per cent of it.

In the matter of Technical Education in Connection with Agriculture in England, Mr. S. Rowlandson has shown that under the stimulation of a parliamentary grant the Royal Agricultural Society has instituted examinations in the science and theory of agriculture, a provision for the teaching of elementary agricultural subjects has been incorporated in the education code, and attention has been given to the matter by the Universities of Oxford and Cambridge. The lack of teachers is the chief obstacle to making the benefits of instruction in the subject real and general.

On the occasion of the transit of Mercury, May 10, 1891, Dr. K. Winder, of Detroit, analyzing the solar spectrum at the point where the planet was projected on the sun's disk, observed that the telluric rays in the light from the edge of the planet were strongly marked and extraordinarily dark, indicating the existence of a dense atmosphere in Mercury and the presence of vapor in it.

Finnic and Russian Lapland constitute one of the coldest regions of Europe. The whole country is within the isotherm of 0° C., while in its interior the isotherms of −1° and −2° describe concentric curves. At Kola the thermometer stands above 0° C. (the freezing-point) only during three months. The winter usually begins on the 15th of September. The long winter, ending in June, is followed by a spring of fifteen days; then summer begins in the first week in July and lasts some six or seven weeks, when the thermometer often shows a considerably warm temperature. In the neighborhood of Enasa the ranunculus blossoms on the 28th of June, chickweed July 3d, meadow geranium July 12th, blackberry July 26th, azalea June 26th, *Linnea borealis* July 20th, and butterwort July 2d.

As a test for the detection of fish oil in linseed oil, Dr. Thomas Taylor recommends silver nitrate solution. On its application the fish oil, if any is present, coagulates and falls to the bottom of the test-tube, displacing the nitrate-of-silver solution. The author declares the test infallible, as the effect is not produced with other oils.

Dr. L. Webster Fox believes from his experiments that savage races have better color-perceptions than civilized races. In a group of one hundred Indian boys he found none color-blind. In another group of two hundred and fifty Indian boys two were color-blind. No color-blind Indian girls were found.

A curious instance of "frugality" in bees has been observed by Mr. M. H. Harris, of Ealing, England. During rainy weather, which promised to interfere with further honey-making, they proceeded to guard against it by ejecting the larvæ of both drones and workers and sucking out the soft contents of the corpses, leaving only the white chitinous covering.

OBITUARY NOTES.

Cardinal Haynald, Archbishop of Kalocsa, who died on the 4th of July last, was the son of a botanist and made himself eminent in that science by his investigations of the flora of Transylvania. Even among his sacerdotal duties and his political ones as member of the Hungarian House of Magnates, and the social obligations they imposed, he found time to continue his botanical studies and publish a few special papers and biographical studies of botanists of his acquaintance. His herbarium was the richest in Hungary and one of the largest private collections on the continent, and was free to students.

The death of two well-known contributors to French scientific journals was announced in the same week in October. M. Edouard Lucas, Professor of Special Mathematics at the Lycée Charlemagne, died of erysipelas following a wound in the cheek made by a piece of a broken dining-plate. He had just been presiding over the Section of Mathematics and Astronomy of the French Association for the Advancement of Science. He was the author of a series of curious mathematical recreations and recondite calculations—as amusing as they were instructive—of which the most famous was that of the Tower of Hanoi. He frequently contributed articles of this character to the Revue Scientifique and La Nature. M. Félix Hément had been Professor of Physics and Natural Science at Tournon, Strasbourg, the Lycée Bonaparte, the Collége Chaptal, the École Turgot, the École Polonaise, and the Israelitish Seminary. He was also a frequent contributor to La Nature and the Revue Scientifique.

Mr. Charles Smith Wilkinson, Government Geologist of New South Wales, died August 26th, forty-seven years old. He was an original member of the Linnæan Society of New South Wales, and its president in 1883 and 1884.

WILLIAM EDWARD WEBER.

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PERSONAL LIBERTY.

By EDWARD ATKINSON, assisted by EDWARD T. CABOT.

IN dealing with many of the questions which come within the domain of the student of political economy or of social science it becomes expedient to refer to the decisions of the courts, especially among the English-speaking people. The paramount question at issue to-day is the maintenance of personal liberty. The precepts upon which personal liberty rest have become incorporated in the common law, and when personal rights are impaired by statute law the complainant may appeal to the courts and may establish his own control over all the factors that are necessary or conducive to his support as a matter of right, so long as he does not infringe the equal rights of others. Among such factors is the right to control one's own time.

One of the most profound changes which has occurred in the relations of men to each other has been the change from status to contract. In ancient days, under ancient law, the place which a man could hold in society was fixed by the condition of his birth, by his relation to his father, his family, or his gens or his class. His individuality was absolutely subordinate to the condition in which he had been born. From the dawn of history contract may have been found in existence, but its fulfillment depended upon its form rather than upon any moral engagement. Sir Henry Maine observes that "the conception" (of contract) "when it first shows itself is rudimentary. No trustworthy primitive record can be read without perceiving that the habit of mind which induces us to make good a promise is as yet imperfectly developed, and that acts of flagrant perfidy are often mentioned without blame, and sometimes described with approbation. In the Homeric literature the deceitful cunning of Ulysses appears

as a virtue of the same rank with the prudence of Nestor, the constancy of Hector, and the gallantry of Achilles."

Elsewhere, Sir Henry Maine, when dealing with the progress of a society resting upon the just relations established by free contract, remarks that "the many have an almost instinctive reluctance to admitting good faith and trust in our fellows as more widely diffused than of old. . . . From time to time these prepossessions are greatly strengthened by the spectacle of frauds unheard of before the period at which they are observed."

"But," as he most profoundly remarks, "the very character of these frauds shows clearly that, before they became possible, the moral obligations of which they are the breach must have been more than proportionately developed. It is the confidence reposed in and deserved by the many which affords facilities for the bad faith of the few; so that, if colossal examples of dishonesty occur, there is no surer conclusion than that scrupulous honesty is displayed in the average of the transactions which, in the particular case, have supplied the delinquent with his opportunity."

In the observations of nearly half a century of business life the writer has become profoundly impressed with the truth of these observations, and has been almost brought to the conclusion that contracts would be fulfilled, commerce would go on, and debts would be paid as fully in the long-settled and well-established communities now existing in many parts of this country, if all laws for the collection of debts and all acts of legal tender were repealed.

When the quality of the money of a nation is evenly maintained, no act of legal tender is needed to enforce its acceptance by a creditor. If there is any other point of dispute, evidence of an offer of the debtor to fulfill his contract in money might be perpetuated without giving him an option to pay in poorer money than he had promised. It is only when the quality of money has been depreciated that an act of legal tender is cited by a debtor, and in so doing he transfers the fraud from his own shoulders to the Government that has impaired the terms of his contract.

In the free states which have been established by the English-speaking people character stands for more than capital in establishing credit; credit rests more upon the high standard of business integrity than upon legal provisions for the collection of debts: under these conditions, freedom on the part of the purchaser and the seller, the employer and the employed, to make just contracts, is the condition of abundant production and equitable distribution, while the very existence of society depends upon the maintenance of personal liberty.

The condition under which man exists is that he shall work. The work may be mental, manual, or mechanical. Some may be

spared for a time from the necessity of work, but, as has been well said by Colonel Henry Lee, "under a free distribution of property it is but three generations from shirt-sleeves to shirt-sleeves."

The entire capital in the richest nation or state, consisting of railways, mills, factories, workshops, and dwellings, together with all the goods and wares of every kind—comprising all that has been saved in a useful form, aside from opening of the ways, the clearing of the land and bringing it into productive condition—will not exceed three or possibly four years' production; in most states it is less. If all could be reconverted into food, fuel, and clothing, and the world should rest wholly from work, all would be consumed in two or three years. In respect to food, the world is always within a year of starvation, yet there is always enough somewhere. Whether the product of each series of four seasons shall be distributed so that all may share the necessaries of life depends upon personal liberty, upon freedom of exchange, and upon the maintenance of the right of every man "to use his faculties in all lawful ways, to live and work where he will, to earn his livelihood in any lawful calling, and to pursue any lawful trade or avocation." (Judge Peckham, of New York. People *vs.* Gilson, 109 N. Y., 399.)

"The patrimony of the poor man lies in the strength and dexterity of his own hands; and to hinder him from employing these in what manner he may think proper, without injury to his neighbor, is a plain violation of this most sacred property." (Judge Snyder, of West Virginia. State *vs.* Goodwill, 10 S. E. Rep., 287.)

In the progress of invention, and by the application of science to the art of material production, all that can be expected or hoped for in the improvement of the condition of the great body of the people is that the more noxious pursuits may be done away with and that the conditions of the most arduous may be ameliorated; but the work must go on and in the sweat of his brow man must always eat his bread. The true gain that comes in the course of years is that a part of the time which is at the disposal of men may be saved from the necessity of hard work for the enjoyment of more and more leisure. Whether the leisure hours will be well spent or not will rest wholly upon the individual. The best definition of leisure that I have ever met is that "leisure consists in the diligent and intelligent use of time." Time saved from the necessary work of life may be worse than wasted or it may be well spent.

In dealing with this subject we are often brought face to face with a singular paradox. If all were rich, all would be poor alike; each might then be disinclined to serve the other for compensation, and thus all would be obliged to do all their own work with-

out opportunity to save labor by mutual service. Under such conditions life would be hardly worth living. Every kind of work would be required of every man and woman and there would be no rest. It is by the exchange of services that time is saved, both to the employed as well as to the employer. The man who directs the force of the capital in the possession of which he makes himself rich adds vastly more to the common product from which all wages and profits are derived, than he consumes for his own use from that product in the personal support of himself and his dependents. When just relations are established by free contract between rich and poor the service which each renders to the other is an equitable and useful service. Society rests for its very existence upon this interdependence of men and upon the inequality in their personal endowments, whether material or immaterial. The capacity to combine, direct, and use great masses of capital is rare: without this capacity capital becomes inert or it is wasted, while labor becomes less productive the more crowded the area occupied. Hence inequality in possession is the very necessity to the productive application of that which constitutes wealth. The value of a man to the community in which he lives is measured neither by his labor nor by his toil, nor by the number of hours that he works; it is established by the service that he renders, and that rests finally upon the quality of the mental energy with which he is endowed and upon the effectiveness of the forces, material or immaterial, to which he gives direction. The mind of man is the prime factor in the conversion of forces to the end that there may be abundance and leisure in place of scarcity accompanied by long hours of arduous toil.

Such being the conditions, it does not follow that every one may not feel a hearty sympathy with any true effort on the part of those who earn their daily bread by the sweat of their own brows, to shorten the hours of labor so as to save more time for rest and recreation. It is only to the false methods by which these ends are sought that exception can be taken.

When these efforts tend to deprive the very men who seek to be benefited of their own personal liberty, and when their right of free contract is impaired by their own acts, the time has come to discriminate in order to separate the true from the false methods of saving time; or, in other words, to distinguish between the true and the false methods of shortening the hours of labor.

It is customary to define three factors which enter of necessity into the production of all material things—land, labor, capital. There are, in fact, two other factors inseparable from production, and each is as essential as the land, the labor, or the capital—namely, the mental power, or, in other words, the mental energy

which is required to direct the processes of labor and capital and the time that is required for the sequence of the several processes of production.

Among these five factors, land, labor, capital, mental energy, and time, there is but one in which all men must share alike. All others are variable. One only is equal and constant, and that is time.

The hours of the day number twenty-four. Whether a man be rich or poor, whether well endowed with mental energy or not, the one opportunity, the one element of property, which all must share alike, is time. Time is a common factor, and yet it is also a separate factor, an element of individual property, with which every man may claim to deal according to his own will so far as he may not impair the rights of others to deal with their share of time at their own will.

It follows that any legal restrictions upon the free use of time impair personal liberty more than almost any other interference with the freedom of men that can be conceived. Such restrictions create inequality in that which in its nature must be shared by all alike.

Yet, step by step, and session by session, the Legislatures of almost every State are enacting statutes restricting the use of time, which, when enforced, create monopolies, establish privileged classes and inflict disabilities. Under pretense of police ordinances or under the pretext of maintaining the public welfare these acts deprive great bodies of citizens of their right of free contract and of the free disposal of their own time according to their own will, even in lawful and in innocuous pursuits in the conduct of which no harm can arise to any other person, although the man himself who chooses to do so may overwork himself.

These restrictions have been carried to such an extent as to have perverted the very moral sense of great numbers of workmen. Many combinations and associations have made demands upon the Legislature to limit adult men and women in the use of their own time who do not wish to be limited by legal restrictions imposed both upon the workman and the employer. The attempt has been made to put a brand or mark of disgrace upon other workmen who choose to maintain their own personal liberty by calling men "scabs" or "rats" and other opprobrious terms, who control their own time and maintain their right to free contract. Resort has even been had in very many cases to force, in this futile attempt to substitute the despotism of democracy through the misuse or abuse of the power of the majority for the despotism of the kings and of the privileged classes whose rule we have thrown off.

It matters not that all such attempts must fail because the

free men who maintain their own personal liberty will in the end secure the best positions and the most lucrative occupation. These efforts, so long as they have a temporary effect, tend to the privation of the very men who move for the enactment of restrictive statutes or who subject themselves to the rules of the associations which limit them in the use of their own faculties.

It is the very province of the political economist to expose the wrong, even if it offends the very men who wrong themselves, and to appeal to the decisions of the courts in order to establish their rights as well as the rights of those who will not submit to their restrictions.

It does not yet seem to have occurred to any of those who are oppressed by such public statutes, or by the rules and regulations of private associations by which the attempt is made to restrict the free use of time, that a remedy may be found in the courts for any infringement of personal liberty, under whatever pretense the public act may have been passed. It may, therefore, be expedient to pass in review some of the cases in which this issue has already been joined.

In order that the firm foundation on which personal liberty rests may be fully comprehended, we may go back almost to the beginning, and we must recur once again to a familiar chapter of the English-speaking people.

The barons who wrested the charter of English liberty, the Magna Charta, from King John, nearly eight hundred years ago, were only maintaining the long existing and established rights of the free men of England against the usurpation of a despotic ruler. Strange that the counterpart of that ruler may be found to-day in the legislatures of our own time.

Personal liberty was established in the Magna Charta in these terms:

"No free man shall be taken or imprisoned or disseised, or outlawed, or exiled, or anyways destroyed; nor will we go upon him, nor will we send upon him, unless by the lawful judgment of his peers or by the law of the land." *

In the brief limits permitted for the statement of this case we may not follow the course of history, century by century; but we must pass at once to a very noted instance in which the rights of the people were established by the English courts, the "case of monopolies," so well known to all students of law and so often cited. In the time of Elizabeth, the Queen had under taken to grant to the plaintiff the monopoly of making and selling playing-cards. The court held this grant to be void, and in giving the opinion

* "Nullus liber homo capiatur, vec imprisonetur, aut dissaisiatur, aut utlagetur, aut exuleter, aut aliquo modo destruatur, nec super eum ibimus, nec super eum mittemus, nisi per legale judicium parium suorum, vel per legem terræ."

cited a previous case in which it had already been held that even a chartered company which had undertaken to establish a somewhat similar privilege had gone beyond its powers. The record of the previous case in part is cited in the following terms (The Case of Monopolies, 11 Coke Rep., 86 a):

"And a case was adjudged in this court, inter Davenant and Hurdis, Trin. 41, Eliz. Rot. 92, where the case was that the company of Merchant Taylors in London having power by charter to make ordinances for the better rule and government of the company, so that they are consonant to law and reason, made an ordinance that every brother of the same society who should put any cloth to be dressed by any cloth worker not being a brother of the same society, shall put one half of his cloths to some brother of the same society . . . upon pain of forfeiting ten shillings . . . and it was adjudged that the ordinance, although it had the countenance of a charter, was against the common law, because it was against the liberty of the subject; for every subject by the law has freedom and liberty to put his cloth to be dressed by what cloth worker he pleases, and cannot be restrained to certain persons, for that would in effect be a monopoly; and therefore such ordinance, by color of a charter or any grant by charter to such effect, would be void."

Again, if any man or woman, or if any family, may choose at this time to work machines in their own houses for a period of time or for a number of hours in the day beyond what is permitted by statute law to be done in the factory, and any one shall molest them, the decision in which it was first held that "a man's house is his castle" may be cited in defense of the personal liberty of the owner and of his right to dispose of his time, of his looms which may constitute his capital, and of his labor in such manner as may serve his own purpose in the best way, according to his own judgment. He may not be forbidden to do that kind of work in his house which is forbidden when conducted in a factory.*

Passing on again by more than a century, we come to one of the great landmarks in the establishment of the liberty of the English-speaking people, noted in the history of jurisprudence—the decision of Lord Camden forbidding action under general warrants. (Entick *vs.* Carrington, 2 Wis. 275, 1765.) The Earl of Halifax, principal Secretary of State, issued a warrant to arrest John Entick "and him having found you are to seize and apprehend and to bring together with his books and papers in safe custody before me." Entick brought trespass against the king's messengers for seizing his papers under this warrant.

* A declaration that a man's house is his castle, and that he may defend it against violence, is contained in Semayne's case, 5 Rep., 91 a (2d Jac. 1).

Lord Camden, C. J. (p. 291): "Our law holds the property of every man so sacred that no man can set his foot upon his neighbor's close without his leave. . . . The defendants have no right to avail themselves of the usage of these warrants since the revolution. . . . We can safely say there is no law in this country to justify the defendants in what they have done; if there was, it would destroy all the comforts of society; for papers are often the dearest property a man can have."

Only a little later, passing to our own side of the ocean, we again find a complete condemnation of all modern acts which impair personal liberty in one of the prime causes of the War of the Revolution. When James Otis resisted the writs of assistance, by which the attempt was being made to compel the citizens of Boston to assist the Surveyor of Duties in searching vaults, cellars, warehouses, shops, and other places for goods which might have been imported contrary to act of Parliament, he cited the common law of England as controlling acts of Parliament, as laid down by Lord Coke.*

When this appeal failed, the colonists threw off the power by which they had been oppressed and adopted the remedy, the terms of which are so well stated by Mr. Justice Gray in his exhaustive review of this chapter in the history of American jurisprudence.†

We are thus brought near to our own time and to the decisions of our own courts, by which personal liberty has been re-established and the right of every man to control the disposition of his own time may be maintained. It seems passing strange that one must resort to the decisions of the courts in order to find a true definition of personal liberty. One would have thought that it would have been found in the very statutes which the courts have annulled.

The very power which Parliament had assumed and which caused the colonies to rebel is now in some directions assumed by the Legislature of Massachusetts. The remedy lies in an appeal to the common law, which is the common heritage of the English-speaking people everywhere, and in this country has been embodied in our written Constitution and Bill of Rights.

Among the many decisions of the courts sustaining the right of every man *sui juris* either to combine with others in the pursuit of a common end, so long as such union or association did not impair the equal right of any one to work at his own will or "for his own hand" outside such unions or associations, none have been more lucidly or firmly presented than those given by Chief-Justice Shaw, of Massachusetts. (Commonwealth *vs.* Hunt, 4

* Bonham's case, 8 Rep., 118 a. † Quincy's Reports, Appendix I, p. 540.

Metcalf, 111, 1842.) The attempt had been made to hold certain men guilty of conspiracy because the members of a union or society had agreed not to work for any person who employed others not members of such union. The learned judge held (p. 128): "The averment is this—that the defendants and others formed themselves into a society, and agreed not to work for any person who should employ any journeyman or other person not a member of such society after notice given him to discharge such workman. . . . (p. 130) The case supposes that these persons are not bound by contract, but free to work for whom they please, or not to work if they so prefer. In this state of things we can not perceive that it is criminal for men to agree together to exercise their acknowledged rights in such a manner as best to subserve their own interests."

The right of the workman to free contract is fully sustained by this decision; he is left as free to refuse to work as he is free to work upon any terms that he may choose to work.

But when the attempt of a slave-master to control the service of him who had been held a slave in another State was made, Chief-Justice Shaw maintained the right of personal liberty in terms which no Congress, no Legislature, and no court would now dare to contravene.*

When Legislatures and trades-unions attempt to impair the personal liberty of men, and to take from them the right to control their own time, the act differs only from the claim of the slaveholder in degree but not in kind; and when an appeal is taken to the courts, the great judge may again annul the act or the ordinance, citing in support of his decision Chief-Justice Parsons, who declared that no slave could breathe the air of Massachusetts; and Chief-Justice Shaw, who ruled that no man should even attempt to impair the personal liberty of him who dwelt upon our soil, even were it only for a single day.

In the case of the People *vs.* Gilson, adjudicated in New York in 1888 (New York Reports, vol. 109, p. 389), Justice Peckham gave a broad and lucid construction to the term "liberty" in the following words (p. 398): "The term 'liberty,' as used in the Constitution, is not dwarfed into mere freedom from physical restraint of the person of the citizen, as by incarceration, but it is deemed to embrace the right of man to be free in the enjoyment of his faculties with which he has been endowed by the Creator, subject only to such restraints as are necessary for the common welfare. Liberty in its broad sense, as understood in this country, means not only the right of freedom from servitude, imprisonment, or restraint, but the right of one to use his faculties

* Commonwealth *vs.* Aves, 18 Pick., 193 (1836).

in all lawful ways, to live and work where he will, to earn his livelihood in any lawful calling, and to pursue any lawful trade or vocation."

The case before the court was one affecting methods of sale of any article of food. The Legislature had enacted a law (chap. 691 of 1887) that "No person shall sell, exchange, or dispose of any article of food, or offer or attempt to do so upon any representation, advertisement, notice, or inducement that anything other than what is specifically stated to be the subject of the sale or exchange is or is to be delivered or received or in any way connected with or a part of the transaction as a gift, prize, premium, or reward to the purchaser."

In respect to this specific act Judge Peckham held it unconstitutional for the following reasons (p. 405): "It seems to me that to uphold the act in question upon the assumption that it tends to prevent people from buying more food than they may want, and hence tends to prevent wastefulness or lack of proper thrift among the poorer classes, is a radically vicious and erroneous assumption, and is to take a long step backward and to favor that class of paternal legislation which, when carried to this extent, interferes with the proper liberty of the citizen and violates the constitutional provision referred to."

In dealing with an act which had been passed to prevent the manufacture of tobacco in tenement-houses, in cities of more than five hundred thousand inhabitants—an act which was specifically aimed at the cities of New York and Brooklyn—Judge Earl held, in the case of Jacobs, 98 New York, p. 98 (1885), that the act was unconstitutional.

Attention may well be called to the vigor with which the learned judge denies the power of the Legislature to construe its own acts by the titles which it may give to them. The assumption of power under the indefinite term of police regulations may not be admitted. The court may demand the facts to be submitted—proof absolute, clear, and definite of the injury to the common welfare may be required before personal liberty can be impaired and the right of free contract taken away, in order that the court may be satisfied that there is reasonable cause to sustain the regulation as one rightly coming within the term of police powers.

A decree in legislative form may present an aspect of legality but may yet be wholly unlawful. Lord Brougham ruled that "things may be legal and yet unconstitutional," even in England where there is no written constitution. Even Parliament has been overruled and called upon to submit to the rule of the courts, when it has impaired the personal liberty of the subject in a manner which is in contravention of the common law, although the act of Parliament may have been wholly consistent with legal forms.

Among the many judges who have ruled in defense of personal liberty none have given more well-considered and vigorous decision than Justice Snyder, of West Virginia. In the year 1887 the Legislature of West Virginia passed an act (chap. 63) to prevent the payment of wages by the issue of what are known as shop orders, or for certain values of goods drawn upon their own shops. This act was held to be unconstitutional (State *vs.* Goodwill, 10 S. E. Report, 285 (W. Va., 1889)). Justice Snyder held as follows (p. 287):

"The property which every man has in his own labor, as it is the original foundation of all other property, so it is the most sacred and inviolable. The patrimony of the poor man lies in the strength and dexterity of his own hands; and to hinder him from employing these in what manner he may think proper without injury to his neighbor is a plain violation of his most sacred property. It is equally an encroachment both upon the just liberty and rights of the workman and his employer, or those who might be disposed to employ him, for the Legislature to interfere with the freedom of contract between them; as such interference hinders the one from working at what he thinks proper, and at the same time prevents the other from employing whom he chooses. A person living under the protection of this Government has the right to adopt and follow any industrial pursuit, not injurious to the community, which he may see fit. And, as incident to this, is the right to labor or employ labor; make contracts in respect thereto upon such terms as may be agreed upon by the parties; to enforce all lawful contracts; to sue and give evidence; and to inherit, purchase, lease, sell, and convey property of every kind. The enjoyment or deprivation of these rights and privileges constitutes the essential distinction between freedom and slavery; between liberty and oppression."

In dealing with the specific act, Judge Snyder (p. 288) declared it to be "a species of sumptuary legislation which has been universally condemned as an attempt to degrade the intelligence, virtue, and manhood of the American laborer, and foist upon the people a paternal government of the most objectionable character, because it assumes that the employer is a tyrant and the laborer is an imbecile."

In the research which the writer has been enabled through the assistance of his coadjutor, Mr. E. T. Cabot, to make in the preparation of this treatise, he has been unable to find any direct adjudication upon the subject of the free use of time.

That no statute may stand which discriminates by classes or by persons in the free use of time, has been well established by a decision in the highest court of California.

A statute of 1880 (p. 80) provided that "it shall be unlawful

for any person, engaged in the business of baking, to engage or permit others in his employ to engage, in the labor of baking for the purpose of sale, between the hours of 6 P. M. on Saturday and 6 P. M. on Sunday, except," etc. The question of the constitutionality of this statute was raised in *Ex parte* Westerfield, 55 Cal., 550. Judge Myrick gave the decision in the following terms:

"This is special legislation. A certain class is selected. As well might it have said, if master carpenters or blacksmiths, or if attorneys having clerks, shall labor or permit employés to labor, they shall be deemed guilty of a misdemeanor and be punished; carpenters or blacksmiths, not master-workmen or attorneys without clerks, may labor at their will. The baking of bread is in itself lawful and necessary. Even if there be authority to restrain the labor on some one day, it must be if at all under a general law restraining labor on that day." Again it is held that if some may not work according to their own will, the rule must be uniform, and all who are engaged in pursuits of like kind must be subjected to the same rule.

Analogous to the use of time is the method of payment. When the State of Pennsylvania attempted to regulate the method of payment which should be adopted under compulsion by the employers who were engaged in mining or manufacturing, and when the State also provided that no employer should sell supplies to the employés at any greater profit than that received from other employés, the Supreme Court declared the statute void.*

In Illinois the Legislature attempted to provide for the weighing of coal at the mines under different conditions from the conditions of weighing or delivery which might apply in other places. The court held the act unconstitutional, as being class legislation.†

The State of New York passed an act against excluding persons from equal enjoyment of places of amusement on account of race, color, or previous condition of servitude, and this act was sustained.‡

There could be no clearer statement of the right of every man to make contracts and to enjoy the free use of time for such number of hours as may be agreed upon by his employer, than that given by Judge Andrews in this case. The learned judge declares not only that life, liberty, and property must be protected, but that every person must be protected in every essential incident in the enjoyment of his rights. Can there be a more essen-

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* Godcharles *vs.* Wigeman, 113 Pa. St., 431. † Millett *vs.* The People, 117 Ill., 294.

‡ People *vs.* King, 110 N. Y., 418.

tial incident to the enjoyment of life, liberty, and property than the unrestricted use of time which all may and must share alike unless prevented by unlawful interference?

We may now observe a tendency in many arts, through the progress of science and invention, to pass out of the great factory so as to become again household industries under better conditions, more favorable to production, and less arduous in their conduct than these same branches of industry formerly were before science and invention had come to their aid and had removed them from the house to the factory. The application of water-power to the conduct of the work in the factory rendered it necessary to place the factory in the narrow valleys alongside the river below the fall, and that tended to the concentration of great bodies of men and women in the textile factory. When these branches of industry were first established and were operated by water-power on a large scale, such had been the arduous conditions of life among the farmers of New England that the well-bred daughters of these farmers found it expedient to go from the farm to the factory, where they worked in low-studded, ill-ventilated, badly lighted, and badly heated rooms fourteen hours a day for a measure of earnings only one half that which their successors secure to their own enjoyment, working ten hours a day in a modern, high-studded, well-ventilated factory.

There has been a natural progress in saving time which is due to the application of art and science to production. Science and invention have shortened the hours of work in spite of the meddlesome interference of statutes, and will continue to do so, paying little regard to statute law except so far as restrictions upon the use of time may put off the day rather than hasten it when the hours of work may be shortened yet more.

The application of steam and illuminating gas again tended to concentrate great forces of men and women in the workshop and in the factory and in the upper stories of city warehouses. The power of steam can not be sent far distances. Illuminating gas can only be carried in large pipes at light pressure on short lines. This phase is passing. Profound changes are working. By means of a wire, power, light, and the direction of the work can be carried long distances. The power of the waterfall in the narrow gorge where there is no room for a factory can be carried on the wire to the far-away uplands, where under the best conditions of life the workshops may be established. Fuel-gas distilled from coal by the seaside or near the bank of the river may be carried in small pipes at high pressure far away from the source where it is generated.

We are just entering upon the period of rapid transit underneath the ground, by means of which men and women may be

moved at will from the center of the great city where they have been confined in the slums to the broad areas of the suburbs where, under better conditions of life, the same work may be conducted even in their households. Is it to be pretended that by the power of legislation the State constable may enter the household of a free citizen of this country and may prescribe to him, his wife, and his children how they shall work and what number of hours they shall operate the loom, the knitting-machine, the sewing-machine, or any other of the appliances which may be set in motion by electrical power, lighted by electric light, and directed by electrical speech at the touch of a button in the wall? If the State constable may not enter the household, may not invade the home, he may not enter the factory or invade "the close," to use the old-time term cited by Lord Camden, where men and women may choose to work according to their own will and to control their own time according to their own judgment.

One may not defend this abuse of legislation under the pretense that it comes within the police power of the State. True, the Supreme Court of the United States has left these matters up to this time to State legislation, but its justices have more than once laid down the rule under which the Legislatures must act or else the supreme power of the land may forbid any restriction upon personal liberty.*

In view of the certainty with which these principles have been laid down and will be maintained by all the courts of this country, may it not be judicious to put an end to the continual attempts of sentimentalists, of pseudo-reformers, and of unenlightened workmen, to impair the personal liberty of adult men and women and to take from them their right of free contract by an appeal to the courts of highest jurisdiction?

Among the facts which Mr. Hugh Nevill cited at the International Congress of Orientalists to illustrate the theory of a philological connection between Egypt and India, was the use of rice-boats by the Goyi caste of Ceylon, which curiously recalls the oracle-boats of Egypt. Rice was still pounded for ceremonial festivals in these boats of stone or wood, while at the ruins of Amrajapura large stone boats were found of dates between B. C. 200 and A. D. 400, which were used to hold rice for the royal alms. The use of an image of Kâmadhenu, the celestial cow, among the Tamils of southern India and Ceylon, must be regarded as a survival of Isis-worship. The image was used as a car at Mulaition, to support an image of Tântondiswara, or Siva, the self-created. The myth and custom were of obscure antiquity, the celestial cow typifying, in southern Indian mythology, the fertility of Nature. The author did not assert that the affinity observed between Egypt and India came from the former place to the latter; for it might or might not date from a time and place before Isis-worship reached its great seat in Egypt.

* Calder *vs.* Bull, 3 Dal., 386 (p. 388).

THE STORY OF A STRANGE LAND.

By DAVID STARR JORDAN.
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"In one strange land,
And a long way from home,
I heard a mighty rumbling, and I couldn't tell where."
—*Negro Melody.*

IT happened a long time ago, it may be fifty thousand years in round numbers, or it may have been twice as many, that a strange thing took place in the heart of the Great Mountains. It was in the middle of the Pliocene epoch, a long, dull time that seemed as if it would never come to an end. There was then on the east side of the Great Divide a deep, rocky basin surrounded by high walls of granite gashed to the base by the wash of many streams. In this basin, we know not how—for the records all are burned or buried—the crust of the earth was broken, and a great outflow of melted lava surged up from below. This was no ordinary eruption, but a mighty outbreak of the earth's imprisoned forces. The steady stream of lava filled the whole mountain basin and ran out over its sides, covering the country all around so deeply that it has never been seen since. More than four thousand square miles of land lay buried under melted rock. No one can tell how deep the lava is, for no one has ever seen the bottom. Within its bed are deep clefts whose ragged walls descend to the depth of twelve hundred feet, and yet give no glimpse of the granite below, while at their side are mountains of lava whose crags tower a mile above the bottom of the ravines.

At last, after many years or centuries—time does not count for much in these Tertiary days—the flow of melted lava ceased. Its surface cooled, leaving a high, uneven plain, black and desolate, a hard, cold crust over a fiery and smoldering interior. About the crater lay great ropes and rolls of the slowly hardening lava, looking like knots and tangles of gigantic reptiles of some horrible extinct sort. There was neither grass nor trees, no life of any sort. Nothing could grow in the coarse, black stone. The rivers and brooks had long since vanished in steam, the fishes were all dead, and the birds had flown away. The whole region wore the desolation of death.

But to let land go to waste is no part of Mother Nature's plan. So even this far-off corner of her domain was made ready for settlement. In the winter she sifted snow on the cold black plain, and in the summer the snow melted into a multitude of brooks and springs. The brooks gradually wore paths and furrows down the large bed, and the sands which they washed from one place

they piled up in another. The winds blew the seeds of grasses about, and willows and aspens crept up the mountain-sides. Then came the squirrels, scattering the nuts of the pine. Other seeds came, too, in other ways, till at last the barren hillside was no longer barren.

The brooks ran over the surface of the crust undisturbed by the fires within, and were clear and cold as mountain brooks should be; but the rain and melted snow will never all remain on the surface. Some of it falls into cracks or joints or porous places in the rock, and from this come underground streams or springs. But in this region a stream could not run long underground without coming in contact with the old still-burning fires. When a crust is formed over the lava, it cools very slowly. When the crust is a rod or two deep, the lava within is almost as well protected as if it were at the center of the earth.

Whenever the water came down into the fire, the hot rocks would be furious with indignation, and tearing the water to atoms they would throw it back to the surface as steam. Then the explosive force of the steam would in turn tear up the rocks, making still larger the hole through which the water came. When the rocks were very hot, a little water upon them would make a terrible commotion like the shock of an earthquake. When much water came down, it would hiss and boil high in the air, as it tried to break the cushion of steam which came between it and the lava.

And all this went on in hundreds of places and maybe for thousands of years. The hot rocks glowed and sweltered in the ground, and the cold snow-water crept after them closer and closer, while more and more vigorously the rocks resented the intrusion. Sometimes the water would go down in a mass through a cleft, when it would be hurled back bodily the very way it came. At other times the water came down little by little, insinuating itself into many places at once. Then the hot rocks threw it back in many little honeycomb channels, and by the spreading of these channels the rocks were at last crumbled to pieces. The hard black lava or the glass-like obsidian were changed to white kaolin as soft and powdery as chalk. And as the water fought its way, gaining a little every year, steadily working between the joints in the enemy's armor and as surely being thrown back with violence if it penetrated too far, the animals and the plants followed in the wake of the water, and took possession of the territory as fast as it was won.

At last the Pliocene times were over, for all times come to an end. The one sure thing on the earth is the certainty of change. With the change of time came on the earth's great winter. The snow-drifts on the lava were piled up mountain-high. Snow is

Lower or Great Falls of the Yellowstone River.*

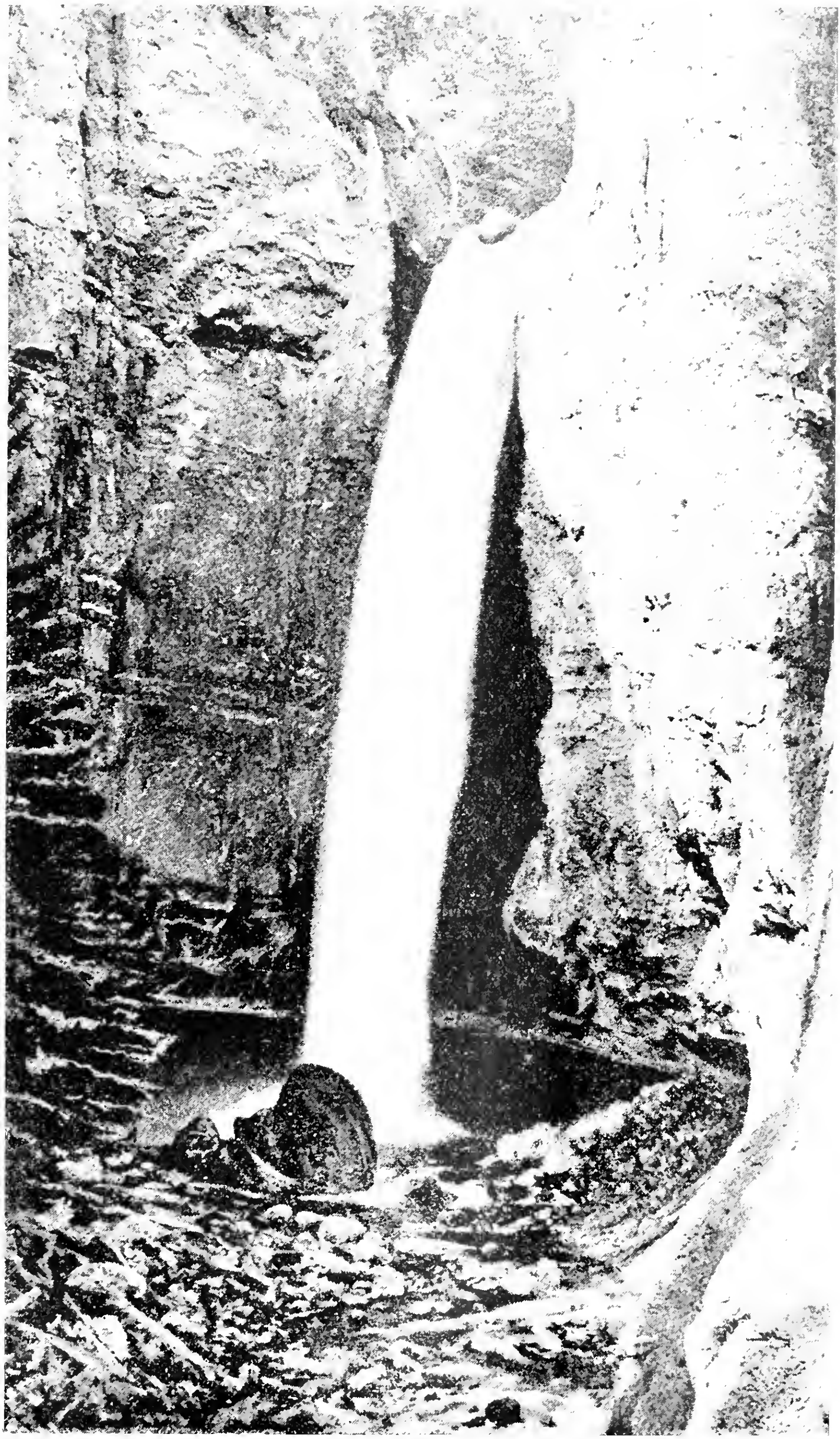
* We are indebted for the illustrations in this article to the kindness of Hon. Marshall McDonald, of the United States Fish Commission.

but ice gathered in little fragments which will grow solid under pressure. As the snow accumulated it began to move, forming great rivers of ice which ran down the courses of the streams. And as these slowly moving, gigantic ice-rivers tore away huge blocks of lava and pushed them down the mountain-sides, where the rocks had been softened by the action of steam, the ice wore out deep valleys, and everything that it touched was smoothed and polished. The winter of the great Ice age lasted a very long time, many thousands of years; but, long as it was and long ago, it came at last to an end—not to a full stop, of course, for even now some of its snow still lingers on the highest peaks that surround the lava-beds.

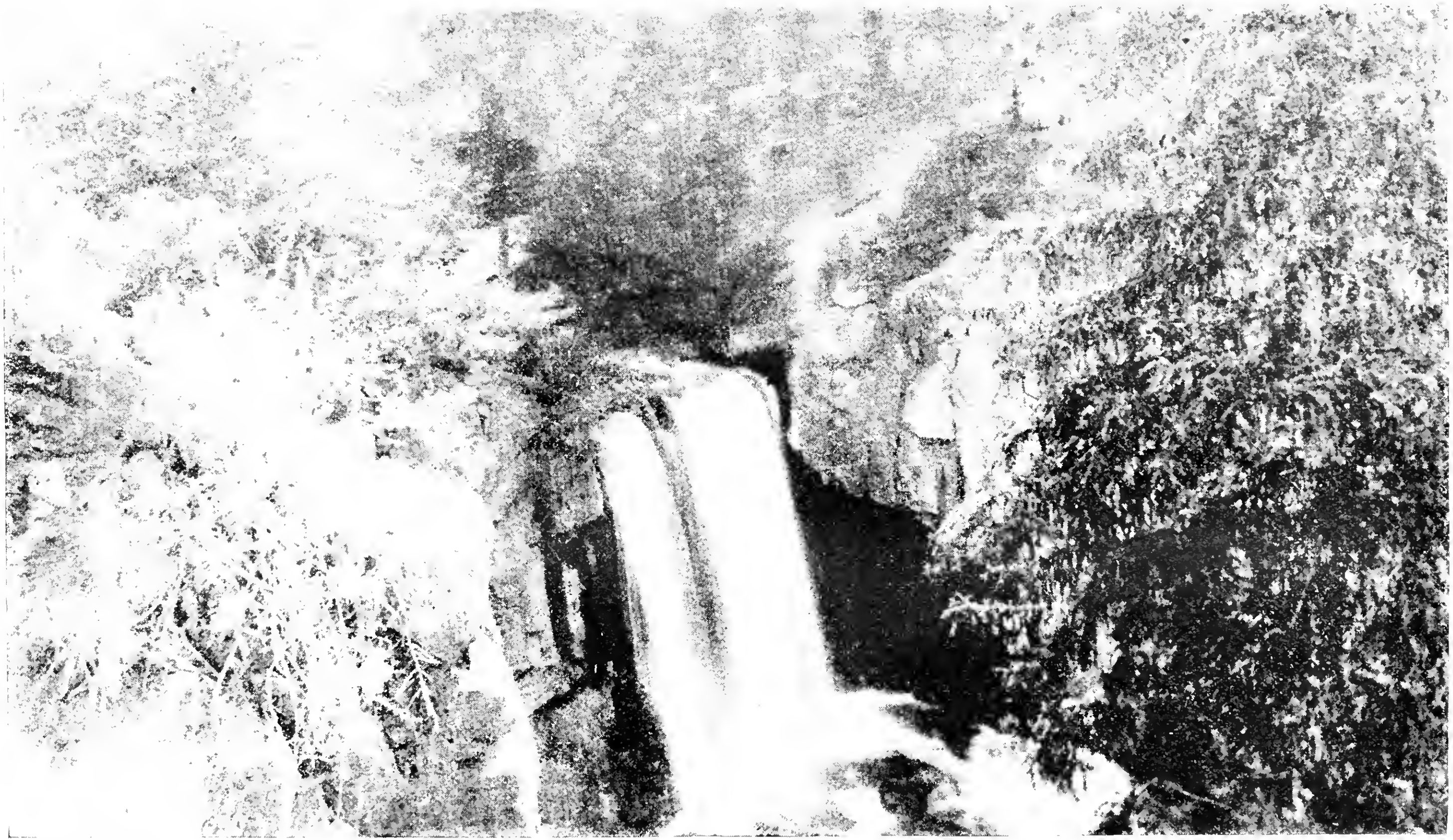
Then the winters grew shorter and the summers longer. The south winds blew and the ice melted away, first from the plain and then from the mountains. The water ran down the sides of the lava-bed, cutting deep gorges or cañons, so deep that the sun can hardly see the bottom. And into the joints and clefts of the rocks more and more water went, to be hurled back with greater and greater violence, for all the waters of all the snow can not put out a mile deep of fire.

In the old depressions where the ice had chiseled away the softer rocks there were formed lakes of the standing water, and one of these was more than thirty miles long, winding in and out among the mountain-ridges. In the lake bottom the water soaked through down to the hot lava below, from which it was thrown boiling back to the surface again, fountains of scalding water in the icy lake.

The cold Ice age had killed all the plants in the region; it had driven off the animals that could be driven, and had then buried the rest. But when the snow was gone the creatures all came back again. Grass and meadow-flowers of a hundred kinds came up from the valleys below. The willow and the aspen took their place again by the brookside, and the red fir and the mountain pine covered the hills with their somber green. The birds came back. The wild goose swam and screamed, and the winter wren caroled his bright song — loudest when there seemed least cause for rejoicing. The beaver cut his timber and patiently worked at his dams. The thriftless porcupine destroyed a tree for every morning meal. The gray jay, the "camp-robber," followed the Indians about in hope that some forgotten piece of meat or of boiled root might fall to his share; while the buffalo, the bear, and the elk each carried on his affairs in his own way, as did a host of lesser animals, all of whom rejoiced when this snow-bound region was at last opened for settlement. Time went on. The water and the fire were every day in mortal struggle, and always when the water was thrown back repulsed, it renewed the contest as vigor-



Tower Falls of Tower Creek.



UNDINE FALLS OF LAVA CREEK.

ously as before. The fire retreated, leaving great stretches of land to its enemy, that it might concentrate its strength where its strength was greatest. And the water steadily gained, for the great ocean ever lay behind it. So for century after century they wrestled with each other, the water, the fire, the snow, the animals, and the plants. But the fishes who had once lived in the mountain torrents were no longer there. They had been boiled and frozen, and in one way or another destroyed or driven away. Now they could not get back. Every stream had its cañon, and in each cañon was a waterfall so high that no trout could leap up. Although they used to try it every day, not one ever succeeded.

So it went on. A great many things happened in other parts of the world. America had been discovered and the colonies were feeling their way toward the Pacific Ocean. And in the vanguard was the famous expedition of Lewis and Clarke, which went overland to the mouth of the river Columbia. John Colter was a hunter in this expedition, and by some chance he went across the mountains on the old trail of the Nez Percés Indians which leads across the Divide from the Missouri waters to those of the Columbia. When he came back from the Nez Percés trail he told most wonderful tales of what he had seen at the head of the Missouri. There were cataracts of scalding water which shot straight up into the air; there were blue ponds hot enough to boil fish; there were springs that came up snorting and steaming, and which would turn trees into stone; the woods were full of holes from which issued streams of sulphur; there were cañons of untold depth with walls of ashes full of holes which let off steam like a locomotive, and there were springs which looked peaceful enough, but which at times would burst like a bomb.

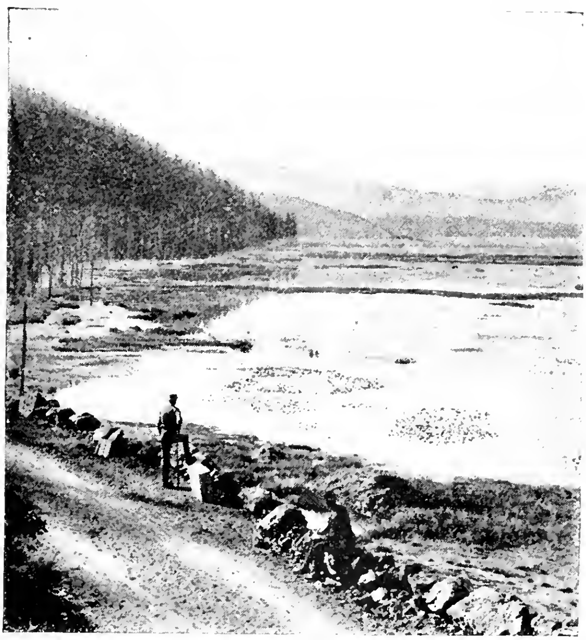
In short, every one laughed at Colter and his yarns, and this place where all lies were true was familiarly known as "Colter's Hell." But for once John Colter told the truth, and the truth could not easily be exaggerated. But no one believed him. When others who afterward followed him over the Nez Percés trail told the same stories, people said they had been up to "Colter's Hell" and had learned to lie.

But, as time passed, other men told what they had seen, until, in 1870, a sort of official survey was made under the lead of Washburne and Doane. This party got the general bearings of the region, named many of the mountains, and found so much of interest that the next year Dr. Hayden, the United States Geologist, sent out a party for systematic exploration. The Hayden party came up from Colorado on horseback, through dense and tangled forests, across mountain torrents, and over craggy peaks. The story of this expedition has been most charmingly told by its youngest member, another John Coulter. Prof. Coulter was the botanist

Osprey Falls of Gardiner River.

of the survey, and he won the first of his many laurels on this expedition. In 1872, acting on Hayden's report, Congress took the matter in hand and set apart this whole region as a "public park or pleasuring ground for the benefit and enjoyment of the people," and such it remains to this day.

But, while only of late this region has had a public history, the long-forgotten years between the Glacial period and the expedition of Lewis and Clarke were not without interest in the history of the trout. For all these years the fishes have been trying to mount the waterfalls in order to ascend to the plateau above.



Beaver Lake; showing Beaver Dams.

Year after year, as the spawning-time came on, they leaped against the falls of the Gardiner, the Gibbon, and the Firehole Rivers, but only to fall back impotent in the pools at their bases. But the mightiest cataract of all, the great falls of the Yellowstone, they finally conquered, and in this way it was done: not by the trout of the Yellowstone River, but by their brothers on the other side of the Divide. These followed up the Columbia to the headwaters of the Snake River, its great tributary, past the beautiful Heart Lake, and then on to the stream now called Pacific Creek, which rises on the very crest of the Divide. In the space between this stream, which flows west to help form the Snake River, and a smaller stream now called Atlantic Creek, flowing down the

Virginia Cascade of Gibbon River.

east slope of the Divide, the great chain of the Rocky Mountains shrinks to a narrow plateau of damp meadow, not a fourth of a mile in width; and some years, when the snows are heavy and melt late in the spring, this whole region is covered with standing water. The trout had bided their time until they found it so, and now they were ready for action. Before the water was drained they had crossed the Divide and were descending on the Atlantic side toward the Yellowstone Lake. As the days went by, this colony of bold trout spirits grew and multiplied and filled the waters of the great clear lake, where their descendants remain to this day. And no other fishes—not the chub, nor the

KEPPLER'S CASCADE OF FIREHOLE RIVER.

sucker, nor the white-fish, nor the minnow, nor the blob—had ever climbed Pacific Creek. None of them were able to follow where the trout had gone, and none of them have ever been seen in the Yellowstone Lake. What the trout had done in this lake—their victories and defeats, their struggles with the bears and pelicans, and with the terrible worm, joint enemy of trout and pelicans alike—must be left for another story.

So the trout climbed the Yellowstone Falls by way of the back staircase. For all we know, they have gone down it on the other side. And in a similar way, by stealing over from Black-tail Deer Creek, they overcame the Undine Falls in Lava Creek and passed its steep obsidian walls, which not all the fishes in the world could climb.

In the Gibbon River the cataracts have proved to the trout an impassable barrier; but, strangely enough, its despised associate, the sluggish, chunky blob, a little soft-bodied, smooth, black, tadpole-like fellow, with twinkling eyes and a voracious appetite—a fish who can not leap at all—has crossed this barrier. Hundreds of blob live under the stones in the upper reaches of the stream, the only fish in the Gibbon waters. There he is, and it is a standing puzzle even to himself to know how he got there. We might imagine, perhaps, that some far-off ancestor, some ancient Queen of the Blobs, was seized by an osprey and carried away in the air. Perhaps an eagle was watching and forced the osprey to give up its prey. Perhaps in the struggle the blob escaped, falling into the river above the falls, to form the beginning of the future colony. At any rate, there is the great impassable waterfall, the blob above it and below. The osprey has its nest on a broken pine tree above the cataract, and its tyrant master, the bald eagle, watches it from some still higher crag whenever it goes fishing.

Two years ago the Hon. Marshall McDonald, whose duty as United States Fish Commissioner it is to look after the fishes wherever they may be, sent me to this country to see what could be done for his wards. It was a proud day when I set out from Mammoth Hot Springs astride a black *cayuse*, or Indian pony, which answered to the name of Jump, followed by a long train of sixteen other *cayuses* of every variety of color and character, the most notable of all being a white pony called Tinker. At some remote and unidentified period of her life she had bucked and killed a tradesman who bestrode her against her will, and thereby, as in the old Norse legends, she had inherited his strength, his wickedness, and his name. And when, after many adventures, I came back from this strange land and told the story of its fishes, other men were sent out from Washington with nets and buckets. They gathered up the trout and carried them to the rivers above the falls, and now all the brooks and pools of the old lava-bed, the fairest streams in the world, are full of their natural inhabitants.

Mentioning some peculiarities in the distribution of plants in Great Britain—that it has a southern flora opposite France, a Germanic flora on the east coast, a Lusitanian flora in the southwest, and on the extreme west two American plants unknown elsewhere in Europe—Mr. Clement Reid expresses the belief that in the Britain of the present day we may study the repeopling of a country over which everything has been exterminated, and, until we have fuller direct evidence of the stages of the process, we may safely accept Greenland and Britain as illustrating the way in which Nature works to fill gaps in the fauna and flora, whether these are caused by changes of climate, by volcanic agency, or by the submergence and reappearance of islands.

URBAN POPULATION.

LESSONS FROM THE CENSUS. IV.

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THE admirable work of Mr. William C. Hunt, special agent in charge of the Population Division of the Census Office, and of Dr. John S. Billings, U. S. A., expert special agent in charge of the Division of Vital Statistics of the Census, enables one to study the relations of urban to country population, and the social statistics of cities. Taking the work of these skillful statisticians and the information which has been collected from other sources, I am able to draw a distinctive lesson relative to congested districts in cities.

In the census of 1880 urban population was defined as that element living in cities or other closely aggregated bodies of population containing eight thousand inhabitants or more. The Superintendent of the Eleventh Census remarks that "this definition of the urban element, although a somewhat arbitrary one, is used in the present discussions of the results of the eleventh census in order that they may be compared directly with those of earlier censuses." He considers the limit of eight thousand inhabitants a high one, inasmuch as most of the distinctive features of urban life are found in smaller bodies of population. According to this definition, the urban population of the United States in 1890 constituted 29·12 per cent of the total population. The following brief table gives the proportion for the several censuses since and including that of 1790:

Census Years.	Population of the United States.	Population of cities.	Inhabitants of cities in each 100 of the total population.
1790	3,929,214	131,472	3·35
1800	5,308,483	210,873	3·97
1810	7,239,881	356,920	4·93
1820	9,633,822	475,135	4·93
1830	12,866,020	864,509	6·72
1840	17,069,453	1,453,994	8·52
1850	23,191,876	2,897,586	12·49
1860	31,443,321	5,072,256	16·13
1870	38,558,371	8,071,875	20·93
1880	50,155,783	11,318,547	22·57
1890	62,622,250	18,235,670	29·12

It will be seen that the proportion of urban population has gradually increased from 3·35 per cent in 1790 to 29·12 per cent, or nearly one third of the total population, in 1890. The number of cities having a population of more than eight thousand increased

from 6 in 1790 to 286 in 1880, since which time the number has grown to 443. New York was the only city in 1880 which had a population in excess of one million, but Chicago and Philadelphia now come into this list. The cities in 1870 which contained more than one hundred thousand inhabitants numbered 14, in 1880 they had increased to 20, and in 1890 to 28. The North Atlantic Division of States, with a population of 17,401,545, contains an urban population of 8,976,426, or 49·22 per cent of the entire urban population of the country. The population of the South Atlantic Division is 8,857,920, and the urban population is 1,420,455, or 7·79 per cent of the entire urban population of the United States. The Northern Central Division, the largest group in the country, has a total population of 22,362,279, and it has a large urban population (5,791,272), which is 31·76 per cent of the entire urban population. The Southern Central Division contains 10,972,893 inhabitants, but its urban population is small, it being 1,147,147, or 6·29 per cent of the urban population of the country. The Western Division, being the smallest group and having 3,027,613 inhabitants, has a city population of 900,370, which is 4·94 per cent of the entire urban population. While the North Atlantic Division contains nearly one half the urban population of the entire country, 51·58 per cent, or more than one half of its own population, is contained in cities of eight thousand or more inhabitants, and during the past ten years this urban element in this division has increased 43·53 per cent, while the total population has increased but 19·95 per cent. The greatest numerical increase in the urban element is to be found in Maine, Vermont, Massachusetts, and New York, so far as the North Atlantic Division is concerned; so that in the States named the rural population must have actually diminished. Of course, this rapid increase in the urban population of the North Atlantic Division finds its cause in the great extension of manufactures and commerce, lines which require the aggregation of inhabitants in restricted localities. This large increase of city population is due in some degree to annexations to already existing cities, but this makes no particular difference with the fact itself, that there is a large and rapidly increasing city population as compared with the population of rural districts.

The bare statement of the facts which I have cited often causes great apprehension as to the character of our population and as to the rapid growth of the influence of cities as controlling powers in the politics of the country, and very frequently it excites the fears of students of social science relative to the supposed increased intensity of the congestion in cities of the slum population. It is upon this latter point that I have for some years made more or less examination, and with a conclusion different from that of statisticians and writers generally. The limits of this series of

papers will not allow me to take up more than three of our largest cities, and I have selected those which have had the largest experience and for which I could most readily study the facts. The population by wards of the cities of New York and Philadelphia for 1870, 1880, and 1890, and for Boston for 1880 and 1890, is shown in the following tables:

New York.

Wards.	1870.	1880.	1890.
First	14,463	17,939	11,122
Second	1,312	1,608	929
Third	3,715	3,582	3,765
Fourth	23,748	20,993	17,809
Fifth	17,150	15,845	12,385
Sixth	21,153	20,196	23,119
Seventh	44,818	50,066	57,366
Eighth	34,913	35,879	31,220
Ninth	47,609	54,596	54,125
Tenth	41,431	47,554	57,596
Eleventh	64,230	68,778	75,426
Twelfth	47,497	81,800	245,046
Thirteenth	33,364	37,797	45,884
Fourteenth	26,436	30,171	28,094
Fifteenth	27,587	31,882	25,399
Sixteenth	48,359	52,188	49,134
Seventeenth	95,365	104,837	103,158
Eighteenth	59,593	66,611	63,270
Nineteenth	86,090	158,191	231,864
Twentieth	75,407	86,015	84,327
Twenty-first	56,703	66,536	63,019
Twenth-second	71,349	111,606	156,859
Twenty-third	......	28,338	53,948
Twenty-fourth	......	13,288	20,137
Total	942,292	1,206,299	1,515,301

Philadelphia—Population by Wards.

Wards.	1870.	1880.	1890.
First	25,817	43,082	53,882
Second	30,220	28,498	31,563
Third	19,119	18,274	19,925
Fourth	20,852	18,854	20,384
Fifth	18,736	16,372	16,987
Sixth	12,064	10,004	8,712
Seventh	31,558	31,080	30,179
Eighth	22,286	19,547	16,971
Ninth	16,629	12,481	9,791
Tenth	23,312	23,362	21,514
Eleventh	14,845	12,929	12,953
Twelfth	15,171	14,690	14,170
Thirteenth	19,956	18,646	17,923
Fourteenth	22,643	22,353	20,737
Fifteenth	44,650	47,866	52,705
Sixteenth	19,256	17,802	17,087
Seventeenth	21,347	20,451	19,546
Eighteenth	26,366	29,358	29,164
Nineteenth	45,240	43,887	55,545

Wards.	1870.	1880.	1890.
Twentieth	56,642	43,207	44,480
Twenty-first	13,861	19,699	26,900
Twenty-second	22,605	31,798	45,329
Twenty-third	20,888	26,644	35,294
Twenty-fourth	24,932	46,071	42,556
Twenty-fifth	18,639	36,108	35,945
Twenty-sixth	36,603	35,138	62,138
Twenty-seventh	19,385	23,333	32,905
Twenty-eighth	10,370	34,443	46,390
Twenty-ninth	......	40,787	54,759
Thirtieth	......	29,098	30,614
Thirty-first	......	31,308	32,974
Thirty-second	......	......	30,050
Thirty-third	......	......	33,171
Thirty-fourth	......	......	23,721
Total	674,022	847,170	1,046,964

Boston—Population by Wards.

Wards.	1880.	1890.	Wards.	1880.	1890.
First	14,773	19,633	Fifteenth	14,902	18,049
Second	15,153	17,297	Sixteenth	15,184	18,048
Third	11,514	13,094	Seventeenth	14,445	15,638
Fourth	11,257	12,842	Eighteenth	13,142	16,035
Fifth	10,960	12,412	Nineteenth	19,971	23,016
Sixth	16,904	18,417	Twentieth	17,391	24,335
Seventh	12,550	13,145	Twenty-first	14,711	22,930
Eighth	12,792	13,026	Twenty-second	12,715	20,011
Ninth	12,611	12,660	Twenty-third	14,032	24,997
Tenth	11,503	8,205	Twenty-fourth	16,871	29,638
Eleventh	16,602	21,660	Twenty-fifth	6,693	12,032
Twelfth	14,696	12,585			
Thirteenth	21,462	22,375	Total	362,839	448,477
Fourteenth	20,005	26,367			

Wards 1 and 2 comprise East Boston; Wards 3, 4, and 5 comprise Charlestown; Wards 13, 14, and 15 comprise South Boston.

The population of Boston by wards for 1870 can not be stated, because the geographical boundaries of wards were changed in 1875; but other data relative to Boston can be used for the illustration of the point I desire to make. In the other cities named, New York and Philadelphia, the geographical boundaries of wards have been identical under the last three Federal censuses. From the foregoing tables I have combined what might be called the "congested" wards of each of the cities. Eliminating these from all the wards, and constructing a new table, we have the facts relative to the population for all wards for the years named, for the congested wards stated separately, and for the remaining wards, in each of the cities. This table is as follows:

	Population. 1870.	1880.	1890.	Gain. 1870 to 1890.	Percentage of gain. 1870 to 1890.
New York.					
Total all wards...	942,292	1,205,299	1,515,301	573,009	60·81
Total congested wards *....	545,653	593,914	596,831	51,178	9·38
Total remaining wards.....	396,639	612,385	918,470	521,831	131·56
Philadelphia.					
Total all wards...........	674,022	847,170	1,046,964	372,942	55·33
Total congested wards †....	436,272	401,795	407,631	‡ 28,641	‡ 6·56
Total remaining wards.....	237,750	445,375	639,333	401,583	168·91
Boston.				1880 to 1890.	
Total all wards.......	....	362,839	448,477	85,638	23·60
Total congested wards #....	....	98,074	99,094	1,020	1·04
Total remaining wards.....	....	264,765	349,383	84,618	31·96
Boston.					
Total....................	250,526	362,839	448,477	197,921	79+
Boston proper............	138,781	147,075	161,330	22,549	16+
Annexations..............	111,745	215,764	287,147	175,402	156+

A study of this last table throws great light upon the supposed concentration of population in the slums of the cities named. In New York the increase in the congested wards (and I have taken for this purpose all the wards south of Fourteenth Street) was in the twenty years from 1870 to 1890 but 51,178, or 9·38 per cent: while the increase for the whole city for the twenty years was 573,009, or 60·81 per cent. The remaining wards, or those north of Fourteenth Street, were the territory where nearly all this last-named gain took place. It was 521,831, or a gain from 1870 to 1890 of 131·56 per cent. Certainly during the twenty years there has been no perceptible increase of population in the congested territory described.

Turning to Philadelphia, and taking the compact wards, we find there has been a loss in the twenty years of 28,641, or 6·56 per cent, the wards other than the congested wards showing a gain of 401,583, or 168·91 per cent, while the total gain for the whole city was 372,942, or 55·33 per cent.

Similar conditions are shown for Boston. In the first section of the preceding table relating to Boston the population for 1880 and 1890 only is given, as explained. This shows that in the ten years named the congested wards, which include all the slum population of the city, the gain was only 1,020, or 1·04 per cent; while in the remaining wards there was a gain of 84,618, or 31·96 per cent. The second section of the table relating to Boston shows the population for 1870, 1880, and 1890 for the whole city—for Boston proper, that is, the old city territory prior to any of its

* First to seventeenth inclusive, except the twelfth, which is an outlying ward.

† Second to twentieth inclusive, except the fifteenth. ‡ Loss.

\# The sixth, seventh, eighth, tenth, twelfth, sixteenth, and seventeenth.

annexations, and the population of the annexations. In the twenty years the population of Boston gained, including all, 197,921, or 79+ per cent; the old city proper gained but 22,549, or 16+ per cent; while the population of the annexations increased 175,402, or 156+ per cent, in the twenty years.

These facts certainly remove all apprehension as to the increase of the slum population of the cities named, and I submit that it is perfectly reasonable that the population of such districts can not increase; and that, while there is a great setting of people toward our cities, they are found as a rule among the suburban population, in healthy sanitary districts; and that whatever influx there is to the slum localities is entirely offset by the outgoing people from such districts.

After collecting the material for this chapter, my attention was called to an exceedingly valuable article in the October Contemporary Review, by Mr. Sidney J. Low, entitled The Rise of the Suburbs. Mr. Low, taking his figures from the recent census of England, that of last spring, makes a table of some of the typical districts of inner London, on both sides of the river, with their rates of increase or decrease since 1881, which is as follows:

District.	Rate of increase or decrease per cent.
City of London	25·5 decrease.
Westminster	19·9 "
Strand	18·2 "
St. Giles	12·1 "
St. George, Hanover Square	10·4 "
Holborn	6·8 "
St. George-in-the-East	3·4 "
Shoreditch	2·0 "
Bethnal Green	1·7 increase.
Mile End	1·8 "
St. Olave, Southwark	1·4 "
Kensington	4 9 "
Whitechapel	4·3 "

In regard to these districts, Mr. Low remarks that some of them are wealthy residental districts, while many of them are poor and others altogether poverty-stricken. "Bethnal Green, Whitechapel, St. Olave, Southwark, and parts of St. Pancras, St. Giles, and Holborn," he says, "are tinted with a very dark brush on Mr. Charles Booth's excellent comparative maps of London poverty." And he further says: "It is not unsatisfactory to find that the dwellers in these localities are obeying the great law of centrifugal attraction, and quitting the inner recesses of the metropolis to find homes in the outskirts. The people who leave Hatton Garden, and Commercial Street, and Hoxton, and Seven Dials, either forced out by 'improvements' or voluntarily retiring, do not go to the country—that we know well enough; nor do the country folks

come in to take their places in any large numbers. For the immigrant from the congested districts of the town, and for the emigrant from the decaying rural parishes, we must look to the suburbs; and we find him there, if figures can tell us anything. Compare, with the list just given of stationary or declining areas in central London, the statistics for a few of the regisration divisions which lie farther out:

District.	Increase per cent since 1881.
Camberwell	26·1
Woolwich	32·8
Wandsworth	46·1
Hampstead	50·5
Fulham	64·5
Tottenham	95·0
Willesden	121·9
Leyton	133·5

"Here is where the increase of 'Greater London,' with its five and a half millions of inhabitants, is found. It is not, as hasty observers have imagined, in the teeming alleys of 'Darkest London,' or in the warren of rabbit-hutches which spreads for a mile or two north and south of the Thames. The center of population is shifting from the heart to the limbs. The life-blood is pouring into the long arms of brick and mortar and cheap stucco that are feeling their way out to the Surrey moors and the Essex flats and the Hertfordshire copses. Already 'Outer London' is beginning to vie in population with the 'Inner Ring'; a few decades hence, and it will have altogether passed it."

These figures for different portions of London are exceedingly significant, and show precisely the same conditions as are shown by the facts which I have already grouped relative to New York, Philadelphia, and Boston, and they show conclusively that the movement is greatly different from what it is often supposed to be. To again quote Mr. Low: "The population is not shifting from the fields to the slums; and the slums themselves are not becoming fuller, but the reverse. So far from the heart of the city being congested with the blood driven from the extremities, we find, on the contrary, that the larger centers of population are stationary, or thinning down; it is the districts all round them which are filling up. The greatest advance in the decade is shown not in the cities themselves, but in the ring of suburbs which spread into the country about them. If the process goes on unchecked, the Englishman of the future will be of the city but not in it. The son and grandson of the man from the fields will neither be a dweller in the country nor a dweller in the town. He will be a suburb-dweller. The majority of the people of this island will live in the suburbs; and the suburban type will be the most wide-

spread and characteristic of all, as the rural has been in the past and as the urban may perhaps be said to be in the present." This aspect of affairs is perfectly reasonable, and is the only condition that could have been expected. It should be remembered that the cities named are great mercantile and manufacturing centers, their prosperity developing rapidly, and it should also be remembered that the rapidity of the development of cities in commercial or industrial ways retards the growth of population in the compact quarters to a very large degree. Every time an advance is made along a street by the extension of business houses, the families living there are crowded out; they may move to other parts of the city or locate in the suburbs; in either event there is only a shifting of population, and not an increase. The transfer of great manufacturing establishments from the city to the country carries large numbers of families, or if the transfer is made within the city limits there is simply a change in location of the population interested in the establishment. In taking the Federal census of 1880 for the State of Massachusetts I discovered a loss in one of the wards of the city of Boston; but I found upon investigation that the removal of one establishment from that ward to another in a distant part of the city had carried with it more than one thousand people; so the increase in the population of the part of the city to which the removal was made apparently indicated growth. Cities lay out new streets and avenues, necessitating the tearing down of rookeries and crowded tenement-houses. Every such improvement displaces a large number of families, who seek a residence either in some other part of the city or in the suburbs. Thus, the building of a large number of houses, often referred to as an evidence of increase of population, may not mean any increase whatever. If a hundred families are crowded out of their old locations by improvements or by the encroachments of trade, there is an immediate demand for a hundred new tenements, which makes it appear that the population is increasing rapidly, when there is no increase. That the argument that new houses always indicate an increase of population is unanswerable can not be admitted, for very frequently the reverse is true, even in a country town a new house or a dozen new houses may not indicate an increase of a single person in the population, as it may be entirely the result of the improved financial condition of one or several families formerly living in the same house. The building of new houses is an indication of prosperity and of increase, but not positive evidence of increase. The retarding influence of the increase of trade and of manufactures must be felt more and more as their extension becomes more rapid, and in all great cities where large business blocks are erected in place of crowded tenements there must be a dispersion of population.

I think that what has been said in regard to New York, Philadelphia, and Boston, and of the city of London, would prove true of any large commercial or manufacturing center. The encouragement to be drawn from this state of facts is great indeed, and should relieve the popular mind of the constant fear of the increase of the slums of our great cities. I wish that an investigation might be made that would show the exact number, character, and condition of the people living in the slums, and whether the geographical territory inhabited by the slums is being enlarged, or whether the actual number on restricted territory is being increased. Such an investigation, whatever it might show, would be of immense value in the study of urban population.

STILTS AND STILT-WALKING.

By M. GUYOT-DAUBES.

SYLVAIN DORNON, a stilt-walker of the Landes, left Paris on the 12th of March, 1891, for Moscow, and reached the end of his journey after fifty-eight days of walking. This long walk on stilts was a subject of wonder, not to the Russians only, to whom this method of locomotion was unknown, but to Dornon's own countrymen as well.

Walking on stilts, which was common some twenty years ago in certain parts of France, is gradually going out of use. In the Landes of Gascony it was formerly a means of locomotion well suited to the nature of the country. The Landes were large continuous plains, covered with scrub bushes and scanty heaths; and, in consequence of the impermeability of the subsoil, all the hollows were transformed after a light rain into marshes. There was no road or path. The population, of sheep-farmers, was greatly scattered. The shepherds evidently conceived and adopted stilts in order to be able to move about under these peculiar conditions. The stilts of the Landes are called there *tchangues,* a word in the *patois* of the country meaning long legs, and the persons who use them are called *tchangués*, or long-legged. They are long sticks, which have at the mean height of about five feet from the ground a stirrup to support the foot. The upper part of the stick is shaved flat and supported against the leg, where it is held in place by a strong strap. The lower part, which stands on the ground, is expanded, and is sometimes re-enforced by a sheep-bone. The stiltsman is assisted by a third stick, which serves him for a variety of uses. It supports him in mounting his stilts, and can be used for a crook in driving his sheep; or, with the addition of a piece of board, it forms a comfortable seat fitted to the height

of the stilts. Resting after this fashion, the stiltsman appears as if seated on a gigantic tripod. When he stops, he knits or spins on the distaff which he carries in his belt.

His usual costume is made up of a kind of sleeveless vest of sheepskin, linen gaiters, and a drugget cloak. On his head he wears a *béret* or a large hat. This outfit was formerly supplemented with a gun for defending the sheep against wolves, and a frying-pan in which to prepare dinner.*

The appearance of the Landais peasants is extremely picturesque, but their life is miserable; they are generally puny and thin, badly fed, and often threatened by fever. Mounted on their stilts, they lead their sheep across the Landes, going over the bushes and herbs, the little ponds, and safely crossing the marshes, without having to look for roads or beaten paths. This elevation, moreover, permits them easily to overlook their sheep, which are often dispersed over a considerable surface. To put on his stilts in the morning, the shepherd sits on the window-sill or climbs upon the chimney-piece; and even when he is in the open field he can attach them while sitting on the ground, and then rise with the assistance of his third stick.

Locomotion on stilts is evidently calculated to suggest peril to persons who are accustomed to walking only on the feet. We estimate the possible danger of a fall from the height of these implements from our experiences of ordinary pedestrians' falls; but the Landais, habituated from infancy to this sort of exercise, acquire extraordinary ease and skill in it. The *tchangué* is perfectly able to preserve his equilibrium; he marches with long strides, halts in a standing position, runs with agility, or executes an occasional acrobatic turn, picking up a stone from the ground, plucking a flower, pretending to fall and rise quickly, or running in a lock-step, etc.

The speed attained by stiltsmen is easily explained, when we regard the superior length of the stride which they can make without enlarging the angle of separation of the legs.

When the Empress Josephine went to meet Napoleon at Bayonne in 1808, the municipality sent a company of young Landais stiltsmen to escort her. Turning back, they very easily kept up with her carriages, although the horses trotted rapidly. During her sojourn at Bayonne, the shepherds on their stilts gave much amusement to the ladies of the court. They ran races, threw money on the ground and all tried to pick it up at once, and performed many exercises of cunning and skill, accompanied with frequent falls. Until very recently hardly any festivals took

* A representation from Nature, of a shepherd of the Landes on his stilts, can be seen in the hall of the Provinces of France, at the Ethnological Museum of the Trocadéro.

place in the villages of Gascony without stilt-races. The prizes usually consisted of a gun, a sheep, a rooster, or something of the kind; and young women sometimes took part in the exercises. Some of the municipalities near Bayonne and Biarritz still organ-

Fig. 1.—Sylvain Dornon, Landais Stilt-walker. (From a photograph by M. Bacour, of Arcachon.)

ize stilt-races, at the seasons when travel to them is greatest; but it is said that the stiltsmen who perform at such times are not real Landais shepherds, but are casuals picked up as they may be found, most frequently from among professional acrobats.

Besides attaining considerable speed, the Landais stiltsmen are

able to run long distances without appreciable fatigue. Formerly, on market days at Bordeaux, long lines of peasants could be seen arriving on stilts, who, though encumbered with sacks and baskets, had come from villages ten, fifteen, or twenty leagues and farther away. Now, the sight of a man on stilts is almost as great a curiosity in Bordeaux as in Paris. The peasant of the Landes comes to the city in a wagon or by railroad.

Stilts are of common use in the Belgian city of Namur, a town which formerly suffered from the periodical overflows of the Sambre and the Meuse. The streets were at such times converted into streams or ponds, and the inhabitants could communicate with one another only by means of boats or on stilts. This condition has been remedied by suitable public works, but the taste for stilt-races and for the organization of societies of stiltsmen has lasted till the present time.

It is said that the stiltsmen of Namur once procured a valuable privilege for their city. The governor had promised the Archduke Albert to send a band of warriors to meet him who should not be on foot or on horseback. He fulfilled his promise with the assistance of two companies of stiltsmen, who performed their evolutions in the archduke's presence. He was so pleased with the spectacle that he gave a perpetual exemption to the city of Namur from the beer-tax. The gratitude of the people toward their stiltsmen, and the esteem in which sports with stilts are held by the youth of Namur, are easily comprehended.

Travelers have seen stilts in ordinary use by natives of several islands of the ocean, especially in Santa Christina of the Marquesas. Here, as in other places, the usage is in consequence of a climatic peculiarity. During the rainy season the lower parts of the island, the surface of which presents few inequalities, are full of marshes, and stilts have been employed from time immemorial as a means of communication over them. It is worthy of remark that the stilts of savage peoples are vastly more ingenious and elegant than those of the Landais shepherds. Marquesan stilts may be seen at the Ethnographic Museum of the Trocadéro and the Marine Museum in the Louvre adorned with really artistic designs and curious sculptures, mostly made with the aid of fire.

Independently of the considerations of facility of communication which have made the use of stilts necessary in some countries, the thought of mounting sticks of greater or less height, in order to appear larger or to excite the curiosity of spectators, seems to have occurred at all times and in all countries. In numerous masquerades artificial giants may be seen—persons who, having thus mounted stilts, excite the admiration of the people. They are a feature of the Italian masquerades. Gigan and his wife are one of the attractions of the carnivals of Lille and Dun-

kirk. In various places we may see Gargantuas, Goliaths, or Saint Georges and Saint Michaels. From the acrobatic point of view, walking on stilts gives occasion for feats of agility easy to execute and amusing to the spectator. Acrobats on stilts have been mentioned in Japan, China, India, and Oceania; and clowns are sometimes seen in circuses executing curious exercises on stilts.

The use of stilts is a sport, an amusement for children. Real stilt-races may be seen every day in public gardens. The peasant youth in the country are adepts in making excellent stilts of forked sticks which they cut in the thickets.

I have been told by a friend that the college students at Brive-la-Gaillarde formerly had a peculiar sport of going on holidays on stilts to what they called viper-hunts. They armed themselves

Fig. 2.—Collegians of Brive-la-Gaillarde returning from a Viper-hunt on Stilts.

with a long rod split at the end, and went on stilts, of course, as a precaution against being bitten. When, in the evening, they passed through the city, still on stilts, each carrying at the end of his rod an adder or two which they called asps or black vipers, they excited a sensation. Women and children ran away from them or fled into the houses to get away from their tricks.

It seems to be a great pleasure to men on stilts to try to throw one another down. Every young stiltsman is ready to attack, to push, or to trip his colleagues. In the public gardens of Paris, in the Luxembourg, for example, where many youth amuse themselves with stilts, wrestling and contests became so frequent that once after an accident the authorities were constrained to prohibit them. These games on stilts seem to be attractive also to the children of the Marquesas Islands. Père Mathias, in his ac-

count of his voyage to those islands in 1745, remarks that the game on stilts holds the first rank among the pleasures of the Kanakas. On their stilts, he says, which raise them three or four feet above the ground, they give themselves up to combats, and great is the laughter that greets the fall of the awkward. These contests are traditional at Namur, and constitute a kind of national tournament. The contestants form two parties. Each camp is composed of seven or eight hundred combatants, with a captain, officers, a banner, and a cockade. The stiltsmen come into the grand square, announced by martial music. Each party occupies its side of the place, waiting for the signal for opening. The bells sound at every attack, flags fly from the windows, and a crowd of spectators and friends attend to witness the sport. At the giving of the signal the camps engage in the attack. At the first meeting a large number of the contestants fall heavily to the ground and lie there without being able to rise, exposed to being

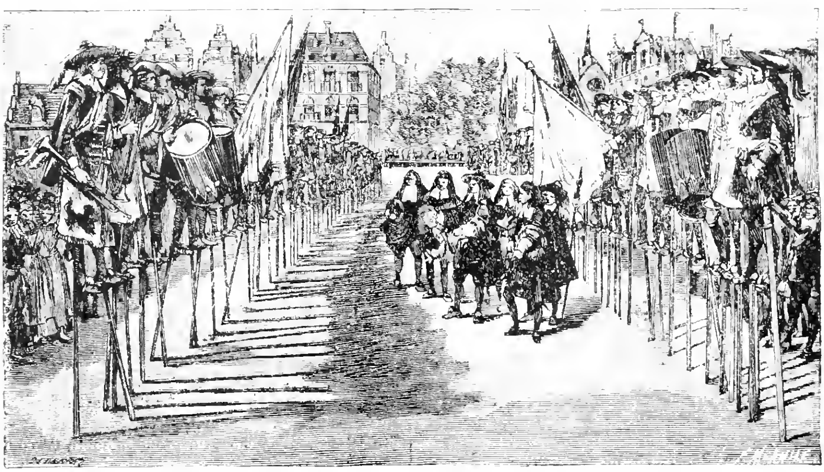


Fig. 3.—Ancient Contests of Stiltsmen at Namur.

trodden upon unless some of the friends who accompany them—wife, mother, or sister—come to their assistance, and lift them up with considerable effort and often after unsuccessful attempts. The contestant, set upon his stilts again, precipitates himself anew into the fight, unless he has been hurt too badly by his first fall. It is not necessary to add that these sports are often dangerous.

The stiltsmen of Namur who gave representations before Charles V, Peter the Great, and Bonaparte, preserve piously in their archives and repeat with pride the saying of Marshal Saxe, that "if two armies should clash together with as much energy as the youth of Namur, the affair would not be a battle, but a butchery."

Stilts are no longer in use as a practical means of locomotion. In France the Landes of Gascony have been drained and reclaimed, and are penetrated by roads and coursed by railways. The Landais *tchangués* are gradually disappearing, and soon, probably, their memory will exist only among the octogenarians of the province, or as preserved in the collections of popular traditions. —*Translated for the Popular Science Monthly from La Nature.*

MUSICAL INSTRUMENTS—THE PIANO-FORTE.

By DANIEL SPILLANE.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XII.

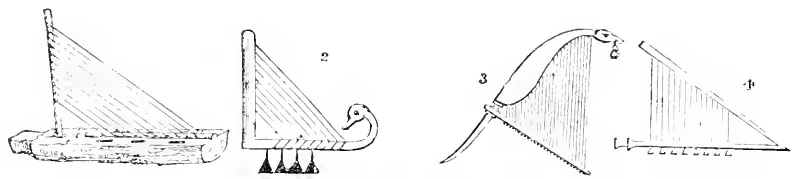
THE place this country holds among modern nations in the production and use of musical instruments is so significant that the fact alone ought to be sufficient to disprove the charge that Americans are too material to appreciate music or the arts. In this and the following article we purpose to treat of the development of musical instruments and their manufacture in America from the historical, technical, and industrial standpoints, with brief sketches of the various improvements and of the individuals identified with them. The piano-forte, the "household orchestra" of the people, is entitled to precedence. Though less complicated and expressive than that "king of musical instruments," the organ, it fills such an important place in social and popular life, and its production maintains such a prosperous art industry, employing within its lines so many gifted men, that this prominence is fully justified.

In treating of the evolution of the piano-forte a little attention must be claimed for the precursors of the instrument. The harp, one of the most ancient, may be traced back in Egyptian history to an indefinable period before Christ. Bruce, the celebrated Scottish traveler and antiquarian, found two paintings, in fresco, of harps on the wall of an ancient sepulchre at Thebes, supposed to be that of Rameses III, who reigned about 1250 B. C. In Thebes, an Egyptian harp was found, in 1823, by Sir John Wilkinson, in an ancient tomb, estimated to be three thousand years old, and when the gut strings were touched they emitted musical sounds. These instruments are illustrated in Fig. 1.

The lyre, a relative form of harp, was also much used in Assyria and Egypt. Ancient sculptures found in Konyunjik, Assyria, now in the British Museum, show two lyres with figures, which further demonstrate its remarkable antiquity. Both instruments

were played with the fingers; sometimes a piece of bone or ivory was used with the lyre as a plectrum.

The dulcimer, which of all musical mediums is nearest to the piano, has been likewise traced into the dim recesses of history,

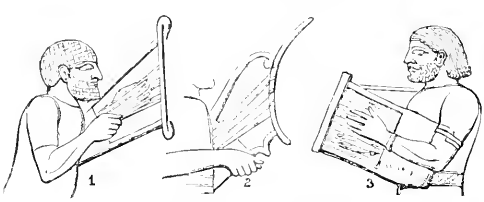


TRIANGULAR HARPS.
1. Ancient Egyptian Harp, from instrument in Egyptian Museum, Florence. 2. Ancient Egyptian Harp (Wilkinson). 3. Ancient Egyptian Harp (Wilkinson). 4. Persian *Chang* (from Persian MS. 410 years old)—Lane's "Arabian Nights."

1 2 3 4
VARIOUS FORMS OF EGYPTIAN HARPS (ROSELLINI).
1 and 3. Portable Harps for single use. 2. Orchestral Harp. 4. From Painting at Thebes, on tomb of Rameses III.

FIG. 1.

and was known doubtless as early as the harp. In a piece of antique sculpture—an Assyrian bas-relief—in the British Museum, a dulcimer may be seen illustrating the principle of sound production in strings by percussion. Another bas-relief represents a procession of triumph after the victory of Sardanapalus over the Susians, where the dulcimer is used.



ASSYRIAN LYRES.
1 and 2. Sculptures from Konyunjik (British Museum).
3. From Botta's "Nineve."

FIG. 2.

Having shown the antiquity of these instruments of the string family out of which the piano has been evolved, we pass over a space of centuries and come to the next major development of the idea. This was the introduction of finger-keys in the organ, which were in the beginning struck with the clinched fist. Guido is said to have first applied them, in addition to his other historic achievements.

The first instrument of the string family with finger-keys was the clavicytherium, or clavitherum, which the Italians produced about the thirteenth century. This was a form of harp with gut strings in which a key-board was employed with finger-keys to move the mechanical leather plectra used for plucking the strings in lieu of the fingers.

The clavichord, an instrument used up to a recent date, came into existence about the same period as the foregoing, and was another step toward the piano. This, like the two instruments mentioned, derived its name from *clavis*, a key. For the first time gut strings were set aside for wire, which were thrown into musical vibration by a *tangent* moved by a key, thus forming a rude anticipation of the first piano-action mechanism. Sebastian Bach used the instrument in his home for purposes of inspiration and practice, while Mozart is said to have carried one on his musical journeys. Beethoven was also partial to the instrument. It had very many advantages over the harpsichord, the only popular instrument of the Mozart and Bach era. For instance, it was possible to produce rude *piano e forte* effects—which results, first attained in the piano, gave it its title—while it had the faculty of action repetition, and a pleasing attribute of being able to simulate human feeling, such as a violinist or vocalist can produce by sliding from interval to interval. As compared with the piano, however, or even the improved harpsichord of the last century, it was a mere toy.

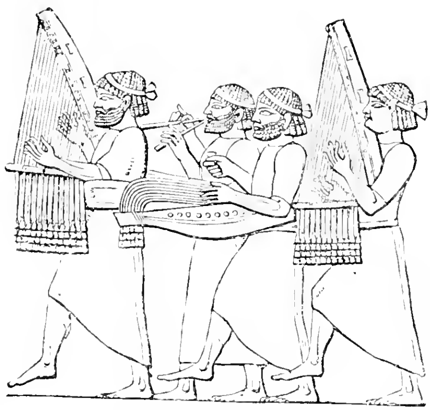


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FIG. 3.—PROCESSION OF TRIUMPH, SHOWING DULCIMER.

The first mention of the instrument discovered in England goes back to 1500, when William Cornish, in his work, A Treatise between Trouth and Informacion, says:

> "The clavichorde hath a tunely knyde
> As the wyre is wrested high and low."

It may have been known previously, however, in that country. Meanwhile, the Germans were generally esteemed as leading clavichord makers at that period.

The virginal and spinet, both forms of the clavicytherium, came next. In these instruments brass-wire strings superseded gut. Instead of a leather plectrum for plucking the strings, a

piece of crow-quill was used attached to a "jack" and operated by a finger-key. The difference between these two instruments was only a slight matter of shape. The virginal was in some cases partially upright. Among the magnificent collection of instruments presented to the Museum of Art by W. A. and Mary E. Brown, of this city, several specimens may be seen. The virginal was a favorite instrument in England during Elizabeth's time. The most noteworthy example of this species in preservation is the Rossi spinet, in the South Kensington Museum collection, London. It has a compass of four octaves and an eighth from E, and is finished in a superb manner. A Player spinet is shown in Fig. 4.

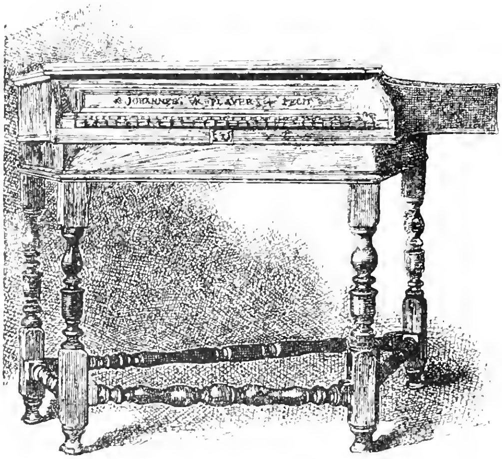

Fig. 4.—Spinet by Player.
South Kensington Museum, London.

Meanwhile musical art had been developing, the compass of keyed instruments was extending, and the harpsichord duly appeared in Italy, which was the home of musical art almost up to the end of the last century. Toward the end of the sixteenth century it had taken the place of the virginal and spinet in many parts of Europe. The harpsichord was an enlarged and improved form of the latter instruments. Among other original features it contained two strings to each note, which marks another important innovation.

Hans Ruckers, of Dresden—Handel's favorite maker—was the most noted of his time. One of his instruments is at present in the possession of the Metropolitan Museum of Art, having been presented by the late Mr. Drexel, of Philadelphia.

In Italy, Father Zanetti, a Venetian priest, became noted for some improvements in the harpsichord about 1702. Crotone and Farino—two famous Italian makers—later appeared. The latter substituted catgut for wire, going back to the harp principle, but it never won recognition. Meantime, one Rigoli, of Florence, made upright harpsichords as far back as 1621. Coming down toward the introduction of the piano-forte, the names of Silbermann, Stein, Peronnard, Marius, Cristofori, and Tschudi must be mentioned. These were all noted harpsichord-makers, representing Germany, France, Italy, and England, but nearly all of them became identified with the production of the piano.

The piano-forte was invented by Bartolommeo Cristofori, a harpsichord-maker of Padua, Italy, who exhibited four instruments in 1709. The honor was formerly claimed for Marius, a French maker, who produced a piano in 1716; while German writers maintained that Schroeter, of Dresden, was the initiator of the instrument. The earliest date ascribed to the latter's achievement, however, is 1711. During the present century, however, an Italian document was discovered, written by Marchese Scipione Maffei, a Florentine scholar, in 1711, which testifies that Bartolommeo Cristofori, of that city, exhibited four pianos in 1709, which statement was originally published in the Giornale in that year, accompanied by a diagram of Cristofori's action principle, employing hammers, which constituted the chief difference betwen the harpsichord and the piano.

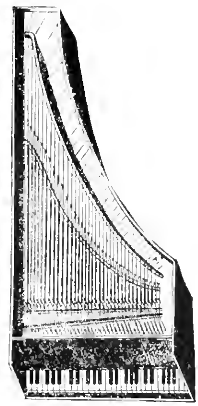

Fig. 5.—Harpsichord.

In Maffei's writings Cristofori's name is given as "Cristofali," but this is proved to be an error, because inscriptions upon existing piano-fortes give the name as "Cristofori."

Father Wood, an English monk, living at Rome, is also said to have made a piano-forte similar to Cristofori's in 1711, which he exhibited in England, where it attracted much notice.

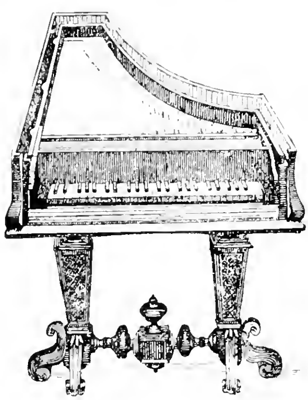

Fig. 6.—Piano by Cristofori, A. D. 1726. Kraus Museum, Florence.

Cristofori did not remain idle after introducing his first instrument. He became prominently known as a maker, but died in 1731, comparatively poor. Two piano-fortes by Cristofori, at present in Florence, dated 1720 and 1726, show that he anticipated the principles of an improved action, and many other points of equal importance in the structure and acoustics of the instrument. One of these is illustrated in Fig. 6. All authorities admit that he was a great figure and a genius of no common order.

England, backward in the production of musical creators or adjuncts to the art in the past, contributed nothing of consequence to supplant the harpsichord, which instrument was largely imported, until the middle of the last century, when Burckhardt Tschudi, a Swiss, settled in London. Tschudi subsequently engaged in the manufacture of piano-fortes, and incidentally founded

the house of Broadwood & Sons, existing at this date in London, and still eminent as piano manufacturers. Plenius, another London harpsichord-maker, attempted to copy Father Wood's piano-forte, but failed to popularize the form, and ceased manufacturing the instrument in a few years.

Throughout England little was known of the piano-forte until the arrival of twelve workmen in London from German shops, about 1760. This turned the tide of popularity in its favor, for, having had practical experience abroad, they produced instruments of more musical value than those experimental pianos hitherto made by Plenius and Tschudi. These men were familiarly known as the "twelve apostles." From Cristofori's time to 1760 all the piano-fortes made were in the form of "grands," but very diminutive as compared with those of our time. This shape was borrowed from the harpsichord, out of which the piano-forte was evolved. Zumpe, however, a German workman, who went over to London among the group indicated, produced square pianos for the first time, which he sold at a reasonable figure; and this feature, combined with their portable appearance and pleasant touch, won rapid popularity for the instrument.

Fig. 7.—John Broadwood.

John Broadwood, the founder of Broadwood & Sons, a young Scotchman, came to London in 1751, and found employment in Tschudi's workshop. He rose rapidly in the favor of his master, and subsequently married the latter's daughter. Afterward becoming a partner, upon the death of Tschudi he inherited the business. Broadwood, by his personal genius as an inventor and workman, rescued Tschudi from being a mere harpsichord-maker, and, toward 1786, Tschudi & Broadwood became pre-eminently known as piano-forte makers. Broadwood was instrumental in introducing the action at present known as the "English grand action," which originated with Backers, a workman in Tschudi's shop, in 1776. Robert Stodart, another graduate of Tschudi's workshop, succeeded to a successful business established by Back-

ers, the inventor of the "English grand action," and died very wealthy. Stodart also contributed many important improvements to the grand. He was followed by his sons, who maintained an excellent record as piano-makers up to recent years.

Sebastian Erard, the founder of the well-known house of Erard, became a leading maker in France toward the end of the last century. He was another important figure in relation to improvements in the grand piano, and also the harp. He was followed by his son Pierre, who became equally famous.

Clementi, the celebrated pianist, a Roman, began business in London in 1800 in partnership with Frederick W. Collard, the latter being the practical partner, and out of this firm the eminent house of Collard & Collard, at present known through Great Britain and Ireland as manufacturers, came. The first Collard was in his time also a great inventor.

Pleyel, Pape, and other French makers appeared soon after the beginning of the century and became famous in Europe as improvers. Many other makers of distinction are known in relation to early piano-making in Germany and elsewhere, but detailed reference to them is impossible here.

John Broadwood introduced an important improvement in the construction of the square piano in 1783, by altering the position of the tuning-pin block—known technically as the "wrest-plank"—from the front of the instrument to the back, a system which has since then been maintained. He also made some valuable improvements in the construction and position of the sounding-board.

John Geib, a German piano-maker, patented and introduced the first "square action" of value in 1786. This became known as the "grasshopper" action, and held a leading place in England and in this country up to 1840. He also introduced the buff stop. Members of the Geib family were among the pioneer piano and organ builders in New York.

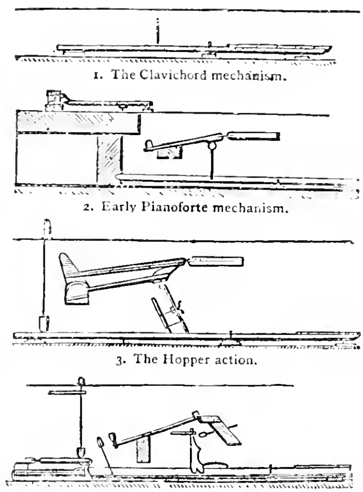

FIG. 8.—ILLUSTRATING THE PARTIAL DEVELOPMENT OF THE PIANO ACTION.

The square piano, which held a favorite place in the United States up to within the past five years, owing to the fact that it was brought to a high point of perfection here, was very popular in Europe as a household instrument up to 1807, when the "cabinet" upright took its place. William Southwell, of Dublin,

some of whose family were prominently known on the early American stage, was the inventor and patentee of the latter instrument. It was produced after fourteen years of persistent endeavor, and, although many persons had previously attempted to make an upright piano-forte of practical value, Southwell was the first to solve the problem in 1807, and it is out of his instru-

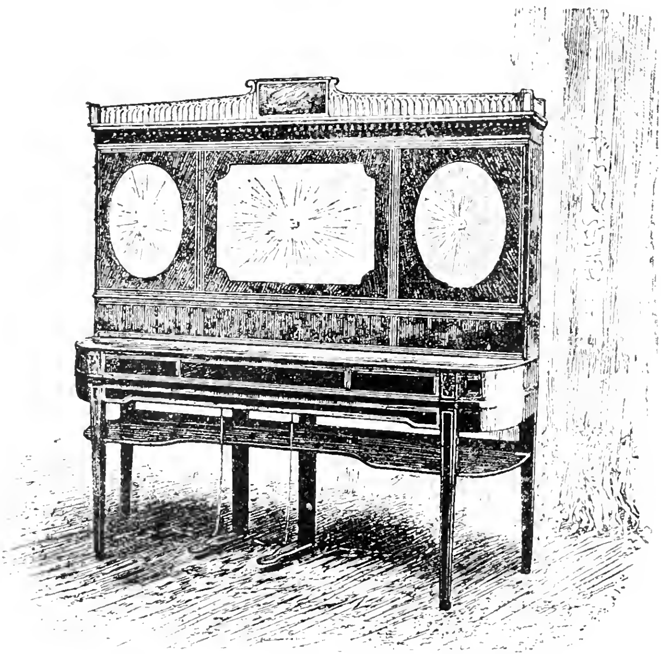

FIG. 9.—SOUTHWELL'S PIANO, A. D. 1798. In the possession of A. Simpson, Esq., Dundee, Scotland.

ment that all subsequent models and modifications of the upright sprang. He also originated the first meritorious upright action ever produced up to his time. This is still known in London as the "Irish" action. One of Southwell's earliest attempts is illustrated in Fig. 9.

It is noteworthy that John Isaac Hawkins, an Englishman, the inventor of ever-pointed pencils, and an engineer by profession, began the manufacture of uprights in Philadelphia in 1800. He took out a national patent in that year for his instrument, which he named "portable grand," and which created quite a furor in that city at the time.

Thomas Jefferson happened to see one of Hawkins's "portable grands" in 1800, while visiting Philadelphia, which he speaks of in the following letter to his daughter: "A very ingenious, modest, and poor young man, in Philadelphia, has invented one of the prettiest improvements in the piano-forte that I have ever

seen, and it has tempted me to engage one for Monticello. His strings are perpendicular, and he contrives within that height to give his strings the same length as in a grand piano-forte, and fixes the three unisons to the same screw. It scarcely gets out of tune at all, and then, for the most part, the three unisons are tuned at once."

One of these instruments is now in the possession of Broadwood & Sons, London. Hawkins was certainly the first to anticipate the modern upright, in its characteristics of portableness, but musically his instrument had no value, and the action principle originated by him was a complete failure. He afterward returned to London, where he achieved an honorable place in his profession. I am indebted to Mr. A. J. Hipkins, the celebrated English writer on musical instruments, and member of Broadwood & Sons, London, for facts given in this connection.

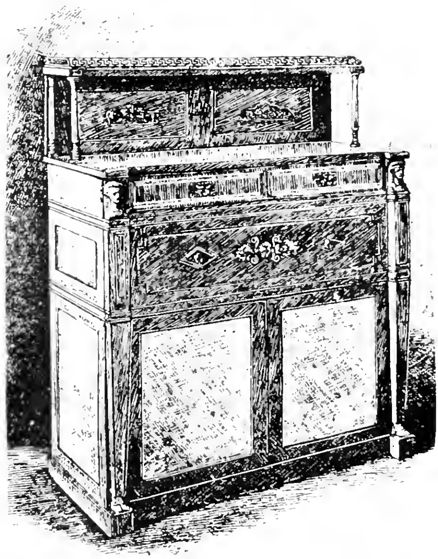

Fig. 10.—First American Upright Piano, made by Hawkins in Philadelphia, 1800. In the possession of Broadwood & Sons, London.

The future of the piano about the beginning of the century depended on the successful introduction of iron; for a point of development had been reached where wooden cases were found inadequate to withstand the tension imposed by heavier stringing and an increased key-board compass. Meanwhile the first notable attempt to introduce iron into the structure of the piano occurred in this country in 1800, when J. Isaac Hawkins, already spoken of, manufactured uprights with iron backs, on which the sounding-board was adjusted. Several rude attempts to employ iron were made subsequently in Europe, but without any degree of success, until Allen and Thoms, two practical workmen in the shop of Stodart in London, originated and patented a system of metal tube and plate bracing in 1820. This attempt was in itself very successful. It became the property of Stodart and proved a fortune to him, but, although an improvement on the old methods, it was far from being adequate to the demands of musical progress. Pleyel, of Paris, and Broadwood, of London, followed with more improvements of the same order, and with partial success, from the

standpoint of the European climate as well as the demands of the limited compass then known. Allen and Thoms later on improved upon their first patent, but not before they had been anticipated in this country by Alpheus Babcock, a piano-maker of Boston, whose invention Jonas Chickering subsequently perfected. Probably it was the obvious inability of London-made pianos to stand our climate, or the intrinsic defects in the system of case-building then in vogue, which attracted the attention of American piano-makers as early as 1790, when cases were put together with screws instead of glue in Philadelphia; anyway, it has long been a subject of pardonable pride to American piano-makers to know that the problem referred to was solved in this country.

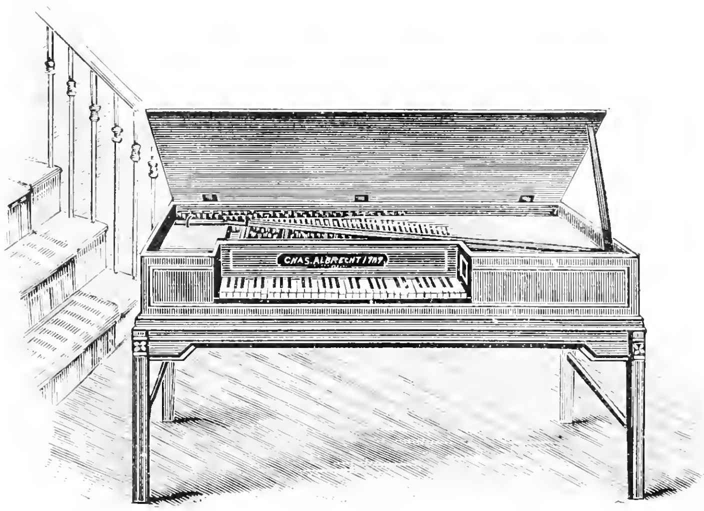

Fig. 11.—The Albrecht Piano, A. D. 1789. Pennsylvania Historical Society. Made in Philadelphia by Charles Albrecht. One of the oldest American pianos known.

In 1775 John Behrent, of Philadelphia, announced that "he had finished an extraordinary instrument by the name of the piano-forte in mahogany, in the manner of the harpsichord." This was probably the first piano made in America. James Julian came forward in 1784, when the Revolutionary War had just been concluded, and advertised the great "American piano-forte of his own invention." In 1789 a piano-forte made by George Ulshofer, a German musician and musical instrument maker and repairer, was exhibited by him in Corre's City Tavern, New York. Some time before this year Charles Albrecht began making pianos in Philadelphia, many notable specimens of which exist to-day. One stands in the Art Rooms of the Philadelphia Historical Society, dated 1789, and another was presented by the late Mr. Drexel to the New York Museum of Art.

I find a definite announcement in 1792, in the first number of the Diary or Lowdon's Register, of February 12th, in which Messrs. Dodds & Claus, musical instrument manufacturers, 66 Queen Street, announce the "*forte piano* of their make, with their own improvements."

Piano-manufacturing in New England was begun by Benjamin Crehore, in Boston, as early as 1798. He had a workshop at Milton, Mass., where he made violins and violoncellos many years previously, but his first piano was produced some time in that year. His workshop proved to be a national school for the art, so to speak, for Alpheus Babcock and John Osborn, the celebrated piano manufacturers of the period, with whom Jonas Chickering learned his business, were apprentices of Crehore's. The first Chickering, therefore, sprang indirectly from the latter's modest factory.

The pioneer makers in New York were Davis, Gibson, Kersing, and Geib—names now almost forgotten, although old instruments of their production may be found occasionally in piano ware-rooms and country houses. All of these were in business before 1800 and upward, but they never attained prominence or wealth.

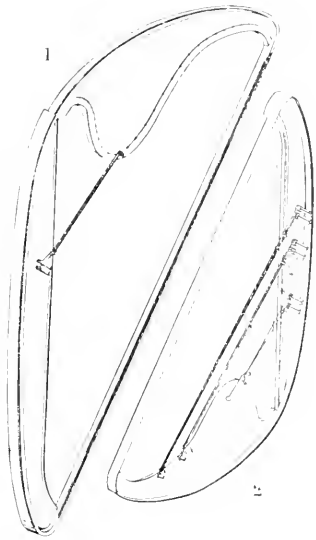

Fig. 12.—Babcock's Skeleton Iron Plates. 1. Patented December 17, 1825. 2. With iron ring, patented May 24, 1830.

The piano industry had attained some footing in America toward 1829, despite foreign competition, for in that year twenty-five hundred pianos were made here—nine hundred being produced in Philadelphia, eight hundred in New York, seven hundred and seventeen in Boston, and a considerable number in Baltimore and Cincinnati. At that period the Loud Brothers, of Philadelphia, were the leading American makers—a position assumed by Chickering & Mackay toward 1840. In Boston, Osborn, Jonas Chickering, and Alpheus Babcock were established—the former being one of the most distinguished of native piano-makers. Babcock, who produced and patented his skeleton iron plate in 1825, moved to Philadelphia in 1830, where he lived for a few years.

Jonas Chickering began business in 1823, in partnership with James Stewart, a practical piano-maker and inventor. Stewart had been previously in business in Baltimore, but came North to become a partner of Osborn, with whom he quarreled in a short time, when a separation ensued. In 1826 Stewart went to Lon-

don, having accepted a position as superintendent of Collard & Collard's. Mr. Chickering entered into partnership with a Captain Mackay at this juncture, and the new firm rapidly rose to a foremost place as makers of pianos, thanks to the inventive and technical genius of Mr. Chickering. In 1841 Captain Mackay died, when the whole business reverted to Chickering.

Jonas Chickering was born in Ipswich, N. H., April 5, 1798. He learned cabinet-making in his native town, and when a mere youth turned his face toward Boston, to find an outlet for his native abilities. On arriving in Boston he found his way into Osborn's shop, leaving it subsequently to enter on a successful career as a manufacturer and inventor. In 1840 he introduced and patented his full solid-cast metal plate for squares, which he carried into grands in 1842. The introduction of these plates marks an era in the history of the American piano.

Fig. 13.—Jonas Chickering.

Upon the death of Jonas Chickering, in 1853, the responsibilities of the business devolved upon his three sons—Thomas E., C. Frank, and George H. Chickering. The first two are dead, the last is the present head of the firm of Chickering & Sons. C. Frank Chickering, the author of the chief developments in the Chickering piano since his father's death, has left behind him a

splendid record as an inventor, while his most artistic labors have been performed in the region of acoustics, or tone development. He was born in Boston, June 26, 1827, where he received his education and professional training. He lived in New York for many years, attaining an influential position in social and artistic circles, and died here March 23, 1891. George H. Chickering was born in Boston, April 18, 1830. Trained under his father's eye in all departments of the art, he was eminently fitted for the province in which he labored up to the time of his brother's death, while time and experience have amply qualified him for the responsible position he now occupies.

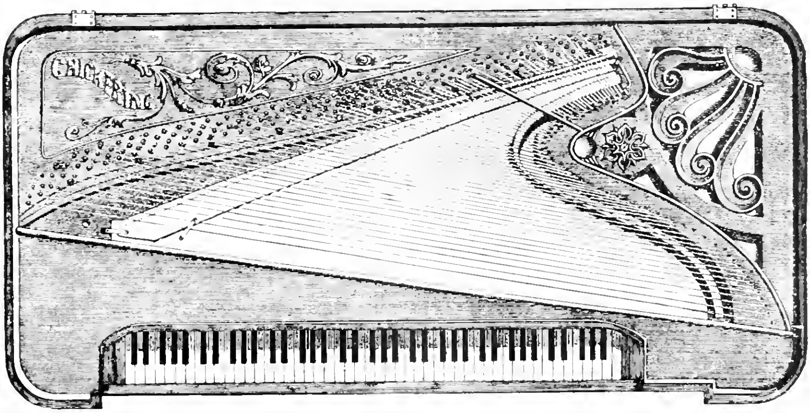

FIG. 14.—CHICKERING'S FULL SOLID-CAST IRON FRAME, A. D. 1840. Also applied to Grands.

Chickering's "circular scale" for squares followed the full metal plate, and this became in later years a direct key to the development of the system of "overstringing" now in general use in this country. Previous to the "circular scale" the hammer heads struck upon an almost straight line throughout, and having, meanwhile, to conform to a standard law which regulates the part of the string on which the hammer is to strike, piano-makers were restricted from bringing forward further improvements in stringing and case structure. Jonas Chickering, however, helped to remove the barriers which impeded progress by running his hammer-heads on a curve. This permitted the introduction of many original features in the general constitution of the instrument, leading up to still greater developments. The improvement was suggested to Chickering by the perfecting of the plate idea, for, having found the latter to be a most satisfactory means of strengthening his cases so as to withstand all extra tension imposed by heavier stringing and an extension of the keyboard, he was placed in a position to move forward, and the "circular scale" for squares was the outcome. This system, however,

was never found applicable to the grand or upright, owing to their different construction, though the late C. F. Chickering took out a patent for a "circular scale" for the latter instrument in 1871.

The term "scale" in the technical vocabulary of the piano-maker means—superficially—the disposition of the strings; but it really means far more, for the scale draughtsman has to make radical changes in the case, action, structure of the plate, and other lesser features to correspond with any changes made in the arrangement or use of the strings. The Chickering "circular scale" is regarded as a most important contribution by old piano-makers, though it was never carried beyond the square.

Loud Brothers, of Philadelphia, had in the mean time brought out and patented many features of moment, which gave impulse to other thinkers, but nothing of consequence comparable with Chickering's achievements. New York makers were not slow to see the advantage of the latter's plates, which were copied in various forms. A few of the more ingenious managed to use plates almost similar to Chickering's, without exposing themselves to legal proceedings. The "circular scale," being an unpatentable species of innovation, was, however, freely copied.

The most notable of the makers in New York around the "fifties" were the Nunns family and Bacon & Raven. The former introduced the French square action into this country, and are known to have brought forward some minor improvements.

The next and most important advance in piano construction was overstringing. In the old system of stringing—which is yet in use among English makers—the strings throughout were placed almost parallel, in harp-fashion. In the illustration of a Chickering plate (Fig. 14), this method of string adjustment may be seen. British and French makers yet stick to the old system to some extent, though they have adopted many of the progressive traits of American pianos. Even the eminent house of Broadwood & Son, London, still use the "flat sealing," as it is called, in preference to overstringing, on the ground that it yields a purer quality of tone. This is only a matter of opinion, however, about which the best makers and experts of Germany and this country differ. One thing, meanwhile, is indisputable—viz., that English pianos lack the power and resonance of American instruments, and would never stand this climate. They are constructed for sweetness and daintiness of tone rather than for volume. American pianos, on the other hand, possess a remarkable combination of all those qualities which are in the highest sense related to musical art.

Overstringing was anticipated about the beginning of the century by the elder Thomas Loud, but nothing came of his experiments. Overstringing—which means simply the crossing of sec-

tions of the strings—was a difficult system to perfect, since it compelled radical changes in the disposition of the hammers, structure of the plate, and other component parts of the piano. About 1853, when the instrument had grown to still larger dimensions and power, thanks to the whole-cast metal plate, a point had been reached where it became apparent that further compass and volume of tone were impossible under accepted stringing conditions. Overstringing was the only avenue to further progress

Fig. 15.—Henry E. Steinway.

in tone-development open to piano-makers; yet few saw it, and those who did were incapable of bringing it to a practical success. The chief points of superiority over the flat scaling are that overstringing permits the dividing up of the tensional pull of the strings upon the case, while it admits of their more advantageous use from the standpoint of tone, and renders the instrument more capable of staying in tune and up to pitch—a most important consideration.

John Jardine—a very clever piano-maker—was one of the earliest to attempt overstringing in this country, but his efforts led to no permanent results. Frederick Mathushek took out a pat-

ent for an application of this method of stringing in 1851, but it never became popular. Steinway & Sons, however, took up the idea in its crude stages a few years later, and applied it successfully. They not only developed overstringing, but it is to them we owe the improved disposition of the strings below. They were the first to exhibit a square piano containing a practical and successful development of the overstringing principle, which has since been accepted everywhere. An instrument made on these improved lines was exhibited at the American Institute Fair in 1855. It was awarded a gold medal, and was practically the parent instrument of that order, not only as regards the arrangement of the strings, but in the structure of the plate and most other general features. Bass overstringing, passing over three bridges, was a noticeable feature in that piano. A full metal plate, covering the wrest-plank, having a solid bar, was also used, with improvements which insured greater resistance against the pull of the strings. Another feature embodied in this instrument was the arrangement of the bridges. These were placed farther in on the sounding-board, so as to bring into sympathy hitherto dormant sections of its surface.

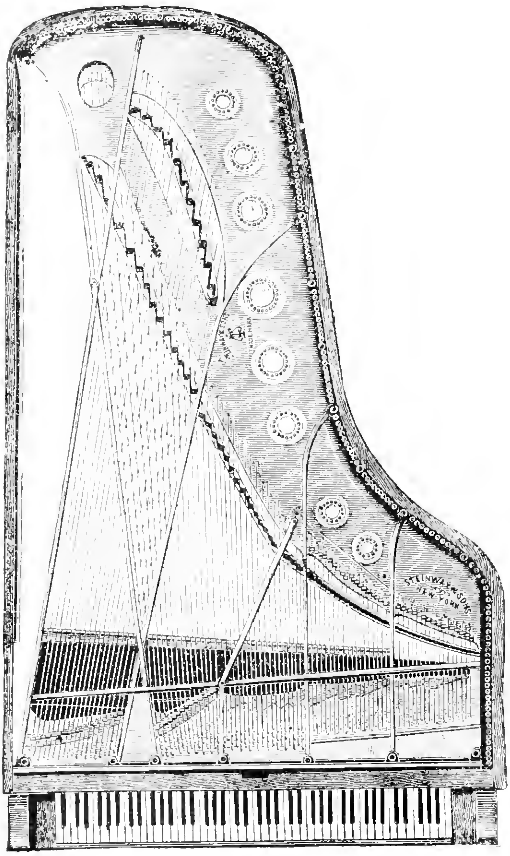

Fig. 16.—Interior of "Steinway" Grand, showing Disposition of the Strings Fan-shape.

Passing over the numerous inventions brought out by Steinway & Sons, following the success of their squares made on the system referred to, their patent for stringing in grands claims a brief notice. This is illustrated in Fig. 16. They were granted a patent for this invention in 1859. In the instruments made on the new lines the strings were spread out in fan-shape, in con-

junction with an original disposition of the bridges, as well as with a striking departure in the construction of the plate, the quality of wire used in the different sections throughout, and in many minor directions. The success of these instruments was pronounced, and the "Steinway" grands were immediately given a foremost place among the leading concert instruments of the world. In 1862 they applied overstringing on a full iron plate, together with many of the most significant features of their squares and grands, to the upright, a form little used in those times, though now holding popular favor to the almost entire exclusion of the square. Since that year they have added patent after patent, and have been most indefatigable in their efforts to improve the character of the piano. Among their other notable inventions must be named their "grand duplex scale," which is now adopted in all their improved instruments. This was introduced in 1872. Their modern grands are remarkable for the character of the action used, as much as for their individuality of tone. This action is a Steinway specialty, and contains many original and effective features, which render it capable of yielding remarkable results in the hands of the artist, the chief features being its power of quick repetition and susceptibility to artistic demands. This brief sketch of their inventions would be incomplete without mention of their "cupola metal frame." This is another improvement in the structure of the modern plate.

The house of Steinway & Sons was founded in 1853 by Henry E. Steinway and his sons, Charles and Henry. The elder Steinway was born in Wolfshagen, in the duchy of Brunswick, Germany, on December 17, 1797. From being an organ-builder he entered the sphere of piano-making at Seesen, where he married and began business on his own account. His three sons, C. Theodore, Charles, and William Steinway, were born at Seesen. Henry E. Steinway won a reputation as a progressive piano-maker from the beginning. In 1839 he exhibited a grand and two squares at the state fair of Brunswick, where he was awarded the prize medal by Albert Methfessel, the composer, who presided as chairman of the jury on the occasion. Meanwhile his sons all grew up in the atmosphere of the piano art business, in which they afterward figured so prominently. In 1850 Henry E. Steinway came to these shores on the advice of his son Charles, who had come over the year before to investigate the field. In 1853, the year of the first American World's Fair, the house of Steinway & Sons was founded. William, armed with an excellent education and a technical training, was taken into partnership late in that year, and since then has been closely identified with the growth of the business.

William Knabe, the founder of Knabe & Co., of Baltimore, whose portrait we give, was another important figure in the development of piano-making in America. Born in Kreutzburg, Germany, in 1803, he came to this country twenty years later with a knowledge of piano-making; and, in association with Henry Gaehle, began manufacturing in Baltimore in 1839. A few years later he started in business for himself. Knabe was instrumental in bringing out many good "scales" and new ideas of similar unpatentable character, and is admitted to have left behind him a worthy record as a maker, being always identified with pianos of the first grade. He died in 1864 in Baltimore.

Fig. 17.—William Knabe.

The late James A. Gray, of Boardman & Gray, of Albany, introduced several inventions of some moment into the square in past years, but with the decadence of that instrument their value ended.

William Lindeman, a native of Dresden, Saxony, and founder of Lindeman & Sons, introduced a "cycloid piano" in 1860, which won some notice from performers and experts. This instrument was a sort of compromise between the grand and square, but it was never a selling success, though a most meritorious and ingenious development.

Among other makers who identified themselves with the square during its popular period, may be named George Steck, John Jacob Decker, Andres Holmstrom, Myron A. Decker, Henry Hazelton, Napoleon J. Haines, and many others, living and dead, whose work in minor details can not be considered here.

The late Henry F. Miller, of Miller & Sons, Boston, and Albert Weber, founder of the eminent Weber firm, also deserve mention. The Miller and Weber firms played no insignificant part in improving the quality of American grands, and uprights as well. Henry F. Miller was a native of Providence, R. I., where he was born in 1825. He became an organist in early life, and subse-

quently drifted into piano-manufacturing in Boston, where he soon won a distinguished place.

The upright, although the popular form in Europe for over fifty years, never won a place here until past 1876, when the showing of these instruments at the Centennial Exhibition stimulated fresh efforts in this direction. About 1882 it had conquered the square as a household form of piano, and since then the latter has been fast going out of use. In fact, in the leading shops the manufacture of squares has ceased entirely.

Southwell's cabinet uprights, already spoken of, were large, clumsy instruments, though the first acceptable pianos in perpendicular shape produced. In 1812 Robert Wornum, a great figure in British piano-making records, brought forward an improved upright with diagonal strings, which, from its portableness and other characteristics, soon became the favorite. In his model the dimensions of the upright were reduced to about four feet six inches, and this subsequently in its improved features became the English cottage piano—a form still in popular favor in England. Wornum also produced a smaller upright in 1826, which he named the "piccolo." These, in addition to valuable action improvements, corresponding in effectiveness with the originality of his instruments, were most significant contributions to the development of the upright up to the latter date. He was also the inventor of the upright "tape-check action," which is now generally used, though with many modern improvements. It was patented in England in 1843, but, strange to say, despite its admitted qualities of excellence, was regarded with little favor in Wornum's own country, Continental piano manufacturers alone taking kindly to it. The upright, meanwhile, received much attention in Europe from piano-makers and improvers, and soon grew into popular favor, to the general exclusion of the square. The European squares, however, were never brought to any considerable degree of perfection, while American squares, on the contrary, were so excellent, toward 1860, that their musical and other qualities served to draw the attention of piano-makers from the upright. The demand for pianos taking little floor-space for household use in the large cities within more recent years drew the attention of makers to the upright as a substitute for the square; and, now that success has been achieved in giving the upright the musical characteristics of the square, the latter is almost out of date.

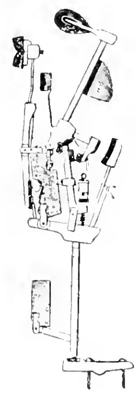

FIG. 18.—SECTION OF IMPROVED UPRIGHT ACTION.

Cabinets and other forms of uprights on English lines were

imported and made in this country about the time they came into use abroad. Timothy Gilbert, of Boston, introduced an improvement in the upright and its action in 1841, but it amounted to little. Jonas Chickering also paid some attention to the perfecting of the instrument, and many excellent uprights of his production may be found, but the public did not take kindly to them at the time. In addition to many minor inventions in the upright, he is said to have applied overstringing to them in 1851. But it was only after 1876 that the upright found any favor in this country.

The late C. Frank Chickering introduced some remarkable upright scales about 1870, having devoted much time and experiment to the perfecting of the instrument, and these were generally copied by competitors of less originality or spirit. Frederick Mathushek, previously mentioned, is also on record as having made some striking advances in the adaptation of the upright form to the popular demand. I have in mind the years preceding 1876. It would, however, be impossible to follow out in detail all the minor contributions made to the upright up to that year.

Excellent uprights are now manufactured by the leading firms, and in all may be found an average in the shape of improvements—the full iron plate in its most modernized form, overstringing with improved acoustic conditions, a good action well regulated, and almost every other feature that existing inventions warrant. But this is not to be interpreted as a declaration that further evolution is impossible. Meanwhile there are specialties in use in the instruments of some firms which I shall try to point out in a brief way. One of the most peculiar of these is the Mason & Hamlin system of tuning and stringing which they have introduced in all their pianos. Notwithstanding a disbelief freely expressed at the outset, their innovation has been, in fact, very successful. Instead of the conventional tuning-pin driven in a pin-block (known as the wrest-plank), they use a screw-headed blade, having a slot at one end for the string, and a screw at the other end by which it can be tightened. The principle is illustrated somewhat in a violin-bow. The blade runs in another slot to keep it from twisting, and the tension of the string is imposed upon a flange cast in the plate. This device is applied to their grands and uprights with most satisfactory results. Decker Brothers, Sohmer & Co., Steck & Co., Weber, Decker & Son, of New York, Hallett & Davis, Emerson Co., Miller & Sons, of Boston, and various other houses, also manufacture instruments with patented improvements, but though most of them are meritorious they are not revolutionary or striking. Behr Brothers, of New York, have, however, attracted much attention with-

in recent years through the introduction of an improved grand-action principle, and a system of stringing, which are illustrated. They are sparing no expense or pains in their efforts to improve the character of their instruments, and such sacrifices are entitled to acknowledgment. Their grand-action improvement assists the production of fine graduations of tone in performance as well as prompt repetition, while their method of string adjustment has been adopted with a view to rendering the instrument more capable of staying in tune, as well as for the purpose of tone development. This is applied to both uprights and grands.

James & Holmstrom, of New York, have recently patented and introduced a "transposing key-board" into their uprights, which is receiving considerable notice from artists. It is an ingenious adaptation of the ordinary key-board, by which the piano-performer may change the pitch at pleasure. Though the idea was anticipated a century ago, and frequently experimented with, it was reserved for Mr. Andres Holmstrom, of the above firm, to apply it with success. It is a great boon to vocalists and artists generally, and of popular value as well. In the invention referred to, the key-board, which is distinct from the action, is made to move a little toward either side, so as to bring the keys under different hammers; the performer is meanwhile given easy and effective control over its disposition, and variations of pitch can be obtained with ease. Apart from this invention Mr. Holmstrom has drawn many excellent upright "scales," which have given him a high reputation among piano-makers.

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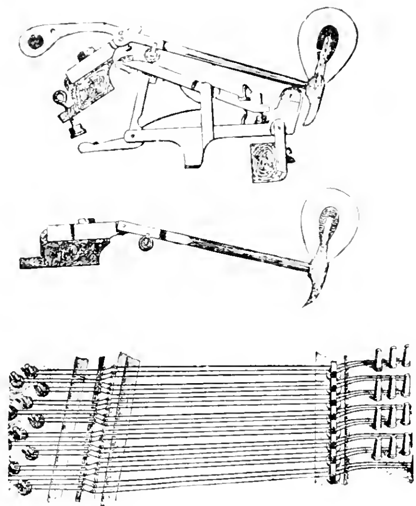

FIG. 19.

1. Behr Brothers' Grand Piano Hammer, with Compensating Lever.
2. Ordinary Hammer and Butt.
3. Behr Brothers' "Stringing Device." (All patented.)

Conover Brothers, of New York, have also patented several inventions of much significance, the author of which is Mr. C. F. Conover, one of the most remarkable of the later-day school of makers. These cover improvements in almost every department of the upright instrument. They include an original tuning-pin arrangement, a method for obtaining prompt repetition in the

action, and a "scale" of especial moment and value. The latter also embraces a departure in plate construction as a part of the whole scheme. Conover's scale contains "duplex bridges" and what are termed "auxiliary vibrators," and in effect is a most meritorious contribution to American piano-making. Their "hollow steel" tuning-pin system is also a significant improvement, while their action is, as far as it is original, equally successful.

Steck & Co., and Decker Brothers, of New York, have been identified with the bringing out of several valuable improvements, which they use as specialties, the most important of which are in the form of scales which can not well be exemplified. The same remark applies to the specialties of several other houses, such as Haines Brothers, Hazleton Brothers, Decker & Son, Kranich & Bach, and others.

Meanwhile I can not pass over the inventions of Paul G. Mehlin, who has done much for the improvement of the modern piano. Though these are numerous and touch every region in the upright piano, his "grand plate and scale" for uprights deserves mention. Through it Mr. Mehlin claims to give the upright some of the principal characteristics of the grand, and the trial to a large extent justifies the claim. The Century Company, of Indianapolis, manufacture the "Mehlin pianos." Mr. Mehlin has taken out a considerable number of patents for improvements in the plate, wrest-plank, action, key-board, scaling, cases, and every section of the instrument since 1872, and has applications pending for more.

Henry Kroeger, of Gildemeester & Kroeger, has also been active as an improver, though his patented inventions cover no radical departures; but his contributions in the form of "scales"

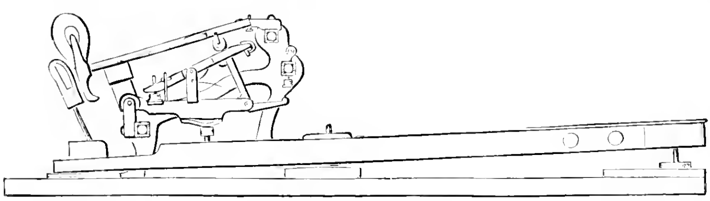

Fig. 20.—Steinway & Sons' Grand Repetition Action, with Tubular Metallic Frame. Patented October 20, 1875.

have been very useful, and during his career he has always been associated with the production of pianos of the highest class. His eminent services deserve this acknowledgment at least. Many other thinkers and inventors, such as Stephen Brambach, of the Estey Piano Company; Myron A. Decker, of Decker & Son; and Hugo Sohmer, of Sohmer & Co., are equally entitled to recognition, though limitations of space prevent more than their mention.

Kindred Industries.—Since 1850 the specializing of such

branches of piano-making as action and key making, and the casting of plates—apart from hammer making and covering, case-making, string and felt making—have helped the general development of the piano to a large extent. Action-making is the largest of all these branches. Formerly a skilled workman was expected to be competent in action-making and half a dozen other branches now separated. While the present system tends to prevent the coming to the surface of such skilled piano-makers as those who built up the principal houses now in existence, and otherwise confines the energies and intellect of clever young men in a narrow channel, yet the existing order of things is on the whole beneficent and better than the old.

The first action-making establishment in New York, and probably in the country, was opened by Andrew Brunet, an Alsatian, in 1841, in Clark Street. His place was very small and unpretentious. He was successful, for small manufacturers saw at a glance the advantages of being able to procure their actions from a specialist. Other establishments sprang up in a short time. While there are numerous small shops throughout New England and in the West, New York is the center for the production of the best class of actions; but Chickering & Sons, Boston, Steinway & Sons, Knabe & Co., Baltimore and New York, and a few other firms, produce their own. The two leaders in this branch of the business are Strauch Brothers and Wessell, Nickel & Gross, of New York. Both firms are engaged in a healthy rivalry for the first place in production and in quality of work, and many technical improvements have resulted from this condition of affairs. They both produce actions involving the same principles, but differing in minor details. Keys are also manufactured specially in New York and outside for the trade.

The production of plates for pianos comes next in importance to action-making. The first foundrymen to become identified with this specialty were the Shrivers, well known in that connection. To-day Shriver & Co., of New York, and Davenport & Tracey, of Stamford, Conn., control the largest proportion of the business.

The wonderful growth and extent of piano manufacturing in America is further illustrated in the business established and conducted by Mr. Alfred Dolge, the well-known initiator of the Dolge system of profit-sharing for employés. In the regions of sounding-boards, felts for hammer-heads and other purposes, and a host of incidental articles, he stands alone. In Dolgeville, a large town he has founded in the northern part of this State, he employs over six hundred hands in his felt and sounding-board factories, and has other establishments in Leipsic, Otterlake, and Port Leyden. Over 35,000 boards were turned out from this factory during the last year. For this purpose 2,800,000 feet of choice lumber were

handled. As each sounding-board represents a piano, one can easily estimate from this basis of observation alone the wonderful dimensions of the piano trade. The unique business in Dolgeville is well worthy of study as a curious example of American industrial life. Its relation to the piano industry is apparent.

In 1850 there were 204 establishments in this country making musical instruments; piano-fortes were not separately reported upon; 2,307 hands were employed, and the product represented $2,580,715. We find that in 1860 21,797 pianos, representing $6,548,432, were manufactured in the United States. The annexed table of statistics shows the industry in 1880, and is the latest:

State.	No. of establishments.	Capital.	No. of workmen.	Wages paid.	Cost of materials.	Value of products.
New York	82	$6,627,845	3,966	$3,213,481	$3,579,131	$8,084,154
Massachusetts	45	1,905,700	1,504	890,721	1,132,847	2,652,856
Maryland	4	638,382	385	200,988	157,699	534,099
Connecticut	3	257,000	302	142,057	182,018	386,583
Pennsylvania	5	169,500	154	87,044	81,145	217,924
Indiana	2	77,000	90	42,500	43,000	109,000
California	6	50,000	27	18,425	41,725	92,700
Kentucky	5	40,700	26	12,833	13,800	42,200
Illinois	5	20,300	27	16,902	11,800	37,675
New Hampshire	3	18,000	32	8,894	15,994	30,380
Missouri	7	21,350	19	10,398	8,060	27,200
Ohio	1	15,000	20	6,000	3,000	15,000
New Jersey	2	10,200	7	4,500	6,000	13,000
Wisconsin	2	10,600	10	4,250	4,500	12,570
Michigan	1	4,000	4	2,200	1,500	5,500
Texas	1	4,000	2	2,000	900	3,500
1880	174	$9,869,577	6,565	$4,663,193	$5,283,119	$12,264,521

When the statistics for 1890 appear, it will be found that the increase in production has been even larger in proportion during the last ten years.

"However prophetic," says Mr. A. H. Green in Nature, "may have been the far-seeing premonition of men in advance of their age in the dim past, and however invaluable may have been the additions made to the superstructure since, it can scarcely be doubted that the foundation-stones of geology were laid by Scotchmen and Englishmen toward the end of the last and during the earlier part of the present century. And what a charm there is about the story of those sturdy pioneers—not perhaps quite the men whom one would have picked out as most fitted or most likely to become the fathers of a new science! It has about it the elements of a genuine romance. For the early training of few of these men was such as to give a scientific bent to their mind; they did not have what we are pleased to call 'the advantage of a scientific education'; it is probable that they never spoke, perhaps never dreamed of such a phrase as 'the scientific method,' which we are so fond of formularizing, and on which we plume ourselves somewhat. But in spite of these seeming drawbacks, rather perhaps because with these men genius was allowed to run its spontaneous, untrammeled course, they opened out to mankind a domain of knowledge, the very outskirts of which had been barely touched upon before.

ELECTRICITY IN RELATION TO SCIENCE.*

By Prof. WILLIAM CROOKES.

THE third annual dinner of the Institution of Electrical Engineers was held at the Criterion on Friday, November 13th. Prof. William Crookes, the president, was in the chair. In proposing the toast of the evening, "Electricity in relation to Science," Prof. Crookes delivered the following speech:

We have happily outgrown the preposterous notion that research in any department of science is mere waste of time. It is now generally admitted that pure science, irrespective of practical applications, benefits both the investigator himself and greatly enriches the community. "It blesseth him that gives, and him that takes." Between the frog's leg quivering on Galvani's work-table and the successful telegraph or telephone there exists a direct filiation. Without the one we could not have the other.

We know little as yet concerning the mighty agency of electricity. "Substantialists" tell us it is a kind of matter. Others view it, not as matter, but as a form of energy. Others, again, reject both these views. Prof. Lodge considers it "a form, or rather a mode of manifestation, of the ether." Prof. Nikola Tesla demurs to the view of Prof. Lodge, but thinks that "nothing stands in the way of our calling electricity ether associated with matter, or bound ether." Higher authorities can not even yet agree whether we have one electricity or two opposite electricities. The only way to tackle the difficulty is to persevere in experiment and observation. If we never learn what electricity is, if, like life or like matter, it should remain an unknown quantity, we shall assuredly discover more about its attributes and its functions.

The light which the study of electricity throws upon a variety of chemical phenomena—witnessed alike in our little laboratories and in the vast laboratories of the earth and the sun—can not be overlooked. The old electro-chemical theory of Berzelius is superseded, and a new and wider theory is opening out. The facts of electrolysis are by no means either completely detected or coordinated. They point to the great probability that electricity is atomic, that an electrical atom is as definite a quantity as a chemical atom. The electrical attraction between two chemical atoms being a trillion times greater than gravitational attraction is

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* Speech delivered at the third annual dinner of the Institution of Electrical Engineers, London, November 13, 1891.

probably the force with which chemistry is most deeply concerned.

It has been computed that in a single cubic foot of the ether which fills all space there are locked up ten thousand foot-tons of energy which have hitherto escaped notice. To unlock this boundless store and subdue it to the service of man is a task which awaits the electrician of the future. The latest researches give well-founded hopes that this vast storehouse of power is not hopelessly inaccessible. Up to the present time we have been acquainted with only a very narrow range of ethereal vibrations, from extreme red on the one side to ultra-violet on the other—say from three ten-millionths of a millimetre to eight ten-millionths of a millimetre. Within this comparatively limited range of ethereal vibrations, and the equally narrow range of sound vibrations, we have been hitherto limited to receive and communicate all the knowledge which we share with other rational beings. Whether vibrations of the ether, slower than those which affect us as light, may not be constantly at work around us, we have until lately never seriously inquired. But the researches of Lodge in England, and Hertz in Germany, give us an almost infinite range of ethereal vibrations or electrical rays, from wave-lengths of thousands of miles down to a few feet. Here is unfolded to us a new and astonishing universe—one which it is hard to conceive should be powerless to transmit and impart intelligence.

Experimentalists are reducing the wave-lengths of the electrical rays. With every diminution in size of the apparatus the wave-lengths get shorter, and could we construct Leyden jars of molecular dimensions the rays might fall within the narrow limits of visibility. We do not yet know how the molecule could be got to act as a Leyden jar; yet it is not improbable that the discontinuous phosphorescent light emitted from certain of the rare earths, when excited by a high-tension current in a high vacuum, is really an artificial production of these electrical rays, sufficiently short to affect our organs of sight. If such a light could be produced more easily and more regularly, it would be far more economical than light from a flame or from the arc, as very little of the energy in play is expended in the form of heat-rays. Of such production of light, Nature supplies us with examples in the glow-worm and the fire-flies. Their light, though sufficiently energetic to be seen at a considerable distance, is accompanied by no liberation of heat capable of detection by our most delicate instruments.

By means of currents alternating with very high frequency, Prof. Nikola Tesla has succeeded in passing by induction through the glass of a lamp energy sufficient to keep a filament in a state of incandescence without the use of connecting wires. He has

even lighted a room by producing in it such a condition that an illuminating appliance may be placed anywhere and lighted without being electrically connected with anything. He has produced the required condition by creating in the room a powerful electrostatic field alternating very rapidly. He suspends two sheets of metal, each connected with one of the terminals of the coil. If an exhausted tube is carried anywhere between these sheets, or placed anywhere, it remains always luminous.

The extent to which this method of illumination may be practically available experiments alone can decide. In any case, our insight into the possibilities of static electricity has been extended, and the ordinary electric machine will cease to be regarded as a mere toy.

Alternating currents have at the best a rather doubtful reputation. But it follows from Tesla's researches that as the rapidity of the alternation increases they become not more dangerous but less so. It further appears that a true flame can now be produced without chemical aid—a flame which yields light and heat without the consumption of material and without any chemical process. To this end we require improved methods for producing excessively frequent alternations and enormous potentials. Shall we be able to obtain these by tapping the ether ? If so, we may view the prospective exhaustion of our coal-fields with indifference ; we shall at once solve the smoke question, and thus dissolve all possible coal rings.

Electricity seems destined to annex the whole field, not merely of optics, but probably also of thermotics.

Rays of light will not pass through a wall, nor, as we know only too well, through a dense fog. But electrical rays of a foot or two wave-length of which we have spoken will easily pierce such mediums, which for them will be transparent.

Another tempting field for research, scarcely yet attacked by pioneers, awaits exploration. I allude to the mutual action of electricity and life. No sound man of science indorses the assertion that "electricity is life"; nor can we even venture to speak of life as one of the varieties or manifestations of energy. Nevertheless, electricity has an important influence upon vital phenomena, and is in turn set in action by the living being—animal or vegetable. We have electric fishes—one of them the prototype of the torpedo of modern warfare. There is the electric slug which used to be met with in gardens and roads about Hornsey Rise; there is also an electric centiped. In the study of such facts and such relations the scientific electrician has before him an almost infinite field of inquiry.

The slower vibrations to which I have referred reveal the bewildering possibility of telegraphy without wires, posts, cables, or

any of our present costly appliances. It is vain to attempt to picture the marvels of the future. Progress, as Dean Swift observed, may be too fast for endurance. Sufficient for this generation are the wonders thereof.—*Nature.*

THE NATIONALIZATION OF UNIVERSITY EXTENSION.

By Prof. C. HANFORD HENDERSON.

I HAVE read with attention the editorial comment on university extension, published in the November number of this magazine, and I am glad to see the subject given so much prominence. The movement has still much of the plasticity of youth, and any discussion regarding its proper ends and aims, or of the means by which these are to be gained, can never be more helpful than now. The present opportunity, it seems to me, is a very large one, and we need the fullest and most impersonal play of thought upon all questions connected with the extension scheme. It is with this feeling in mind that I welcome most heartily the editorial dissent from the proposition to make the work a national activity. The proposition is assuredly a grave one, not only as regards university extension, but even more because it involves a distinct principle of governmental policy, which is either to be courted or to be shunned.

If I may ask for a little further space, I should like to add a word concerning this proposition, which, it is needless to say, was not lightly made. And I should like to speak again, not so much in defense of the proposition—for one must not, in such an inquiry, allow one's self the attitude of an advocate—as to point out that there is another way of looking at national co-operation with university extension than as a subsidy for the movement. And I am the more ready to speak, because it seems to me that perhaps the editorial dissent is not so much against the proposition actually made in the article under discussion, as against a proposition which *might* have been made, and was not, but which presented itself to the mind of the critic as he read.

It is objected that university extension must depend for its success upon individual zeal and public spirit—to which, of course, I fully agree—and that government aid would defeat this purpose. But such a result is by no means necessary. It would depend entirely upon the way in which the aid was given. At present, university extension centers are established quite by private action, and the societies for the extension of university teaching simply co-operate with the local center in providing lecturers, issuing syllabi, and the like. The local center, be it remembered, meets

all its own direct expenses. But the central office must meanwhile be sustained. At present this is done in most cases by private subscription. It is a benefaction, and bounded by all the limitations of a benefaction. Under this arrangement it is quite clear that a center can only be established where there are people of means willing to make themselves responsible for the local expense in case the sale of lecture tickets does not provide sufficient funds. The freedom of the individual to avail himself of university extension is, therefore, limited by the double contingency of local conditions and the facilities possessed by the nearest central office. In no case, it is to be observed, does the central office suggest courses, or pay for them.

Now, it was not proposed that Government should assume the paternal duty of establishing lecture courses in the arts and sciences here and there over the country, like so many intellectual post-offices. But it was proposed that the establishment of local centers should be left, as now, to private initiative and enterprise, while the Government should simply assume the duties of the central offices on a larger and more liberal scale. The work promises to be much too large for private enterprise, and since it does not pay for itself, it can not, in private hands, be thoroughly and systematically done with regard to the country at large. The movement would not be pauperized or degraded by such nationalization. There would be the same play for individual zeal and public spirit as now. But there would be this difference: it would everywhere find established and adequate co-operation where now it finds only special and metropolitan co-operation.

I think that the experiment would not be very dangerous, and it need not be very expensive. Once established, these district central offices of the Department of Education might with perfect propriety go a step further, and provide, under suitable conditions, for part of the expense of an extension course where the proceeds from the sales of lecture tickets were not sufficient. With the people themselves directly creating each center, electing their own subject, choosing their own lecturer, and paying for all or part of the local expense, I really do not see how the movement could become commonplace or mercenary in its character by being systematized under national auspices. There would be room here for an enthusiasm which could be followed by performance.

Like most lovers of freedom we are often too jealous of it to use it. The chief incapacity for greatness in republican administrations is that we are at heart cowards. We make our own government, and are then very much afraid of it. It is as if we feared that this thing which we have ourselves created should turn and devour us; and this distrust is everywhere fostered by the current belief that American politics is very corrupt. Un-

doubtedly it is corrupt, but it will well bear comparison with the activities of private life, with banking and mining enterprises, with railroads and telegraphs, with buying and selling. An impartial review of American history during the decade just passed will disclose a remarkable result, and one which deserves emphasis here and elsewhere:

The sum of American public infamy is neither absolutely nor relatively so great as the sum of American private infamy.

On all sides we hear the reverse. It is preached to us from pulpit and from press, for the human mind has ever shown a willingness for that light gymnastic which consists in setting up a man of straw and then knocking him down. It is better to face the truth. Our Government is corrupt only because our society is corrupt, and it is less corrupt than society because vice is a mortal coward and never does its worst in the open. The electric light has much increased the morality of large cities. The necessary publicity of national action does not insure honesty, but at least it prevents much dishonesty. In those departments in which the Government does attempt to serve us in a positive capacity, such as the Post-Office, the Coast Survey, the Smithsonian, the Geological Survey, the Weather Bureau, the Department of Agriculture, and the like, the service is certainly truer and more effective than parallels from private corporations. I know that Mr. Gould says that the mails would be better administered as private enterprise, but the history of the Western Union Telegraph Company hardly bears out the remark. In view of the experience of the nation, I do not think that university extension need fear corruption should it be included in the portfolio of the incoming Secretary of Education.

Nor is it by any means a proved case that there is a paralyzing lack of vitality in our public schools. It is often asserted, but, taking America as a whole, it seems to me that they are very much alive. It is true that they are commonplace, so commonplace indeed that a conscientious educator will often ask himself whether he should consent to such a system, and will hesitate as to whether he should not withdraw from the public service. But if he will look around him he will see that they are the schools of a commonplace community, and are as good as the community will tolerate. Even in Boston, Alcott's Temple School could not live. One must admit that the public schools are in many ways deplorable tread-mills, and that there are serious scandals in their administration; but they also will well bear comparison with private institutions. They have, moreover, this great advantage, that they permit a freedom and honesty of expression not always tolerated in those institutions which hang for support upon private pocket-books and prejudices. In judging of our public schools

we must always bear in mind their constituency. They are the schools of the populace as well as of the higher classes. If we take the attitude of mind of the average American citizen and compare it with the standards of life represented by the public schools, and then take the culture of the educated classes and compare it with the ideals set forth by private institutions, we shall find that, relatively speaking, the public schools are on much the higher plane; and surely no other mode of comparison can commend itself to our sense of fairness. Instead, therefore, of mistrusting the lesson of the public schools, I should be glad to believe that in five years—no, in ten years—university extension would be doing *in its line* as effective work as our poor commonplace public schools are doing in theirs.

I have tried briefly to answer the expressed objections to the nationalization of university extension; but these do not represent to me the gravest of the possible objections which might be urged, and I am also disposed to believe that under the editorial comment there was a more fundamental dissent in mind. The question, I take it, is essentially not one of experience as to what sort of a servant the Government has been in the past, but is the deeper question of the proper function of government. Had experience shown the public service to be relatively poor instead of being, as I believe, relatively good, I should still advocate its ministration if social studies led to the conclusion that public serving was desirable. The remedy would then lie, not in abolishing the service, but in purifying it. On the other hand, had experience been most favorable, more favorable by far than it has been, and could it be shown on sound theoretical grounds that such governmental activity was mischievous and likely to lead to encroachments upon ultimate personal liberty, it would be one's clear duty to set one's self resolutely against the public convenience and abolish such dangerous service.

Speaking in a large way, there are in America to-day two classes of political thinkers: those who believe in a paternal government, which shall say what one shall eat and drink, what one shall wear, how long one shall work, at what age one shall send one's children to school, what precautions one shall take against loss of life—in a word, a government which shall be a special if not always a very wise providence to each of its citizens; and there are those who, mistrusting this meddlesome paternalism, would go to the other extreme, and would limit the functions of Government to a minimum. The first class is apt to include those well-meaning but mischievous reformers who wish, like the prohibitionist, to cure society by medicine in place of hygiene, and that part of our professional class who have drawn their social ideals from bureaucratic Germany. The second class

takes in those, perhaps, who have studied the political writings of Herbert Spencer, and have translated his sturdy and wholesome demands for the largest possible individual liberty to require a perpetually negative attitude on the part of the Government.

It is difficult to say which class, if left to itself, would make America the more unendurable.

It is this question of our ideal of government which is involved in the proposed nationalization of university extension, and not a mere question of past or probable experience.

This opens one of the most profound problems in our American political life, and one which may be stated indeed but scarcely discussed within such brief limits as the present. Yet feeling that the issue under discussion has its solution in the solution of this larger question, I can not refrain from calling attention to the very doubtful character of the liberty which is to be enjoyed under a *régime* of social and governmental negations. Writers of the sentimental school of political economy—a school which oddly enough includes many prosaic labor agitators of the present day—fairly gloat over their picture of the ideal liberty enjoyed by man in his pre-social existence. But there are many who can feel no enthusiasm for this impossible picture. Place a naked man on an island in the Pacific, and, however generous Nature may be, however free he may be from the tyrannies of modern society, it would be the worst mockery to speak of him as enjoying liberty, for liberty, as a man of any imagination must perceive, presupposes not only the absence of restrictions upon individual action, but also the presence of certain conditions which will make those desired actions possible. In a word, *liberty is a positive and not a negative condition.* Again I venture upon the use of Italics to emphasize what seems to me a most important truth. When we contemplate the narrowing and annoying restrictions which the holders of the ideal of a paternal government would impose upon American life—the eternal *thou shalts* and *thou shalt nots* of prohibitionists and dictators of all classes—the temptation is to swing to the opposite extreme of the pendulum, and declare that absolute non-interference on the part of Government is the only safeguard. When, further, one reads Herbert Spencer's admirable volume on Justice—admirable, that is to say, excepting his unfortunate utterances on the status of woman in the state—one is, at first, confirmed in this negative retreat. The sole function of Government is to insure the greatest possible individual liberty consistent with the liberty of all. This is the conclusion which one of the most profound thinkers of the century reaches at the end of a long and thought-crowded life. And one could ask for no better definition. But how is this conclusion to be applied? That is the question. There is a tend-

ency, it seems to me, on the American side of the Atlantic, to misinterpret this principle, and to discredit too much the immense power for good in proper governmental activity. And even Herbert Spencer himself, gazing too steadily upon the slavery of socialism and the mischief of protection and prohibition, warrants in a measure such a misinterpretation. It is true that governmental activity run wild is as harmful as a thunderbolt, but, when chained to the right sort of service, it is as useful as the electric current. It is possible to apply the salutary principle laid down in the volume on Justice in a manner that will avoid the evils of both paternalism and of too great passivity. Nor is this playing with fire. The line between legitimate and illegitimate governmental activity is easily drawn. What is mandatory in government must not much exceed the Decalogue, or it trespasses on that individual liberty which it is the sole function of government to promote. But the field of action is not so narrow as this. There is a large region of what may be called permissives, in which an intelligent Government may with perfect propriety make individual actions possible, which would otherwise be quite impracticable, and this is very different from the spirit of the Decalogue. Every free Government does at the present time extend a large measure of mere verbal permission to its citizens, but this is rather a gratuitous bit of graciousness, if it do nothing to see that adequate means are obtainable.

We have, then, an easily applied test of the propriety of any governmental action. If it compel, beyond the primal social necessaries—the prevention of murder, theft, adultery, and the like—it is mischievous, and is to be resisted as an encroachment upon individual liberty. But if it render intelligent assistance in making desirable individual action possible, it is to be hailed as a legitimate extension of individual liberty, and is to be utilized as a fruit of the progress of civilization in precisely the same spirit that we would utilize the inventions of Siemens or Edison. One is free, for instance, to write a letter to any one in any place, but he is the more free in that Government delivers it for him at a cost so small that the very poorest may write. There is much that is most desirable to be accomplished in America through national action, and it seems to me that we cheat ourselves sadly if we hesitate to use so powerful a means out of fear that it shall be misused. The more it is properly used, the better will its function be understood, and the less likely to be abused.

Viewing the function of Government in this light, I still believe that the nationalization of university extension is highly desirable, for I believe that, by supplying adequate means for the carrying out of a great idea, it would add immensely to that indi-

vidual liberty which it is the special province of Government to conserve, and this, too, without any loss of individual zeal and initiative.

Let us repeat it: A governmental activity which compels, is mischievous; an activity which says: "Thou mayst; lo, here are the means," is helpful.

IS MAN THE ONLY REASONER?

By JAMES SULLY.

THE "whirligig of time" may be said to be bringing to the much-neglected brutes an ample revenge. The first *naïve* view of the animal mind entertained by the savage and the child is a respectful one, and may perhaps be roughly summed up in the formula in which a little boy once set forth his estimate of equine intelligence: "All horses know some things that people don't know, and some horses know more things than a great many people." But this pristine unsophisticated view of the animal world, though its survival may be traced in mythology and religious custom, has long since been scouted by philosophers. Thinkers, from Plato downward, have, not unnaturally perhaps, regarded the faculty of rational thought, which they themselves exhibited in the highest degree, as the distinguishing prerogative of man. The Christian religion, too, with its doctrine of immortality for man and for man alone, has confirmed the tendency to put the animal mind as far below the human as possible. And so we find Descartes setting forth the hypothesis that animals are unthinking automata.

Not forever, however, was the animal world to suffer this indignity at the hands of man. Thinkers themselves prepared the way for a *rapprochement* between the two. More particularly the English philosophers from Locke onward, together with their French followers, pursuing their modest task of tracing back our most abstract ideas to impressions of sense, may be said by a sort of leveling-down process to have favored the idea of a mental kinship between man and brute. This work of the philosophers has been supplemented by the leveling-up work of the modern biologist. There is not the least doubt that the wide and accurate observation of animal habits by the naturalists of the last century has tended to raise very greatly our estimate of their mental powers. So that it would seem as if in the estimation of animal intelligence, scientific knowledge is coming round to the opinion of the vulgar, and as if "the conviction which forces itself upon the stupid and the ignorant, is fortified by the reasonings of the in-

telligent, and has its foundation deepened by every increase of knowledge." *

Definiteness has been given to the question of the nature of animal intelligence by the new doctrine of evolution. If man is descended from some lower organic form, we ought to be able to make out not merely a physical but a psychical kinship between him and the lower creation; and the more favorable estimate of the animal mind taken by the modern *savant* is of great assistance here. Mr. Darwin has, indeed, shown in his valuable contributions to the subject, that the rude germ of all the more characteristic features of the human mind may be discovered in animals. At the same time, Mr. Darwin's investigations in this direction amounted only to a beginning. The crux of the evolutionist, the tracing of the continuity of crude, formless animal inference, up to the highest structural developments of logical or conceptual thought, still remained. And so, the most powerful attack on the theory of man's descent has come from the philosopher, the logician, and the metaphysical philologist, who have combined to urge the old argument that conceptual thought indissolubly bound up with language sets an impassable barrier between man and brute.

Mr. Darwin's unfinished work has now been taken up by one who adds to the biological knowledge of the expert a considerable acquaintance with psychology. In his previous volume, Mental Evolution in Animals, Dr. Romanes took a careful psychological survey of the animal world for the purpose of tracing out the successive grades of its mental life. In his recent volume, Mental Evolution in Man (Origin of Human Faculty), he essays to trace forward this general movement of mental evolution to the point where logical reasoning or "conceptual thought" may be distinctly seen to emerge. That is to say, he adroitly seeks to leap the "impassable" barrier by merely denying its existence. Human reasoning and animal inference are not two widely dissimilar modes of intellection. The one is merely a more complex expansion of the other. If you start either at the human or the animal bank you can pass to the opposite one by a series of stepping-stones. In other words, the higher human product can be seen to have been evolved out of the lower by a continuous process of growth.

Dr. Romanes's present contribution to the theory of evolution is thus emphatically the construction of hypothetical stepping-stones for the purpose of passing smoothly from the territory of animal to that of human reasoning. In order to this, he has on the one hand to follow up animal intellection to its most note-

* Prof. Huxley, Hume, p. 104.

worthy achievements, and on the other hand to trace the process of human intellection down to its crudest forms in the individual and in the race.

As it is obviously language which marks off human thought from its analogue in the animal world, our author is naturally concerned to limit the function of language. While allowing as a matter of course that the "conceptual thought" of the logician involves language as its proper instrument or vehicle, he urges that there is a good deal of rudimentary generalizing prior to, and therefore independent of, language. To establish this a careful examination of the higher processes of animal "ideation" has to be carried out. In doing this Dr. Romanes introduces a number of psychological distinctions of a somewhat technical kind. Of these the most important perhaps is that between the time-honored *concept* of the logician and the *recept*. This last corresponds to Mr. Galton's generic image or the common image (*Gemeinbild*) of the German psychologists. It is an image formed out of a number of slightly dissimilar percepts corresponding to different members of a narrow concrete class, such as dog or water. According to our author, animal reasoning remains on the plane of recepts. It is carried on by pictorial representations. At the same time it involves a process of classification or generalizing. A diving-bird must be supposed to have a generalized idea (recept) of water, a dog a generalized idea of man, and so forth. Nay, more, this receptual ideation enables the animal to reach "unperceived abstractions," as the idea of the quality of hollowness in the ground, and even "generic ideas of *principles*," as when the writer's own monkey having discovered the way to take the handle out of the hearth-brush by unscrewing it, proceeded to apply the principle of the screw to the fire-irons, bell-handle, etc.

The author's whole account of this receptual ideation or the logic of recepts is interesting and persuasive. He has, it must be owned, clearly made out the existence of a very creditable power among animals of carrying out processes analogous to our own reasonings without any aid from language. Yet a doubt may be entertained whether the author has really got at the bottom of these mental feats. The whole account of the recept is a little unsatisfactory, owing to the circumstance that the writer does not make it quite clear in what sense it involves generalization. He writes in some places as if the fact of the generic image having been formed out of a number of percepts corresponding to different members of a class, e. g., different sheets of water seen by the diving-bird, gives it a general representative character. But this, as indeed Dr. Romanes himself appears to recognize in other places, is by no means a necessary consequence. A generic image may form itself more readily than a particular one, just

because the animal is unable to note differences sufficiently to distinguish one sheet of water or one man from another. A baby's application of the common epithet "dada" to all bearded persons suggests not that it is carrying out any process of conscious generalization, but rather that it is failing to discriminate where there are striking and interesting features of similarity. It would seem as if an idea only acquires a properly general function after certain higher intellectual processes have been carried out. These may be roughly described as the active manipulation of percepts and images, by analytical resolution of these into their constituent features, and a due relating or ordering of these elements. Only in this way does it appear possible to reach a rudimentary form of a properly *general* notion; that is to say, an idea which is consciously apprehended as representing common features among a number of distinct objects. Mere superposition of images may result in a new typical image; but the mind in which such an image forms itself can not know this to be generic or general till these processes which underlie active thought have been carried out. Now, we ourselves carry out these operations of resolving into elements and recombining these elements (analysis and synthesis) largely by the help of class-symbols or general names, which come to be general symbols just because we make use of them for the purpose of noting down and keeping distinct the results of our successive comparisons and analyses. And the really pressing question for the evolutional psychologist is, How does this manipulation of the mind's imagery get carried out where the serviceable instrument of language is absent? That it does get carried out to some extent may be readily allowed. A sagacious and well-bred collie, who combines with a judicious preference for his owner a certain mild complacency toward mankind at large (with some possible exceptions), may be rightly regarded as having attained to a rudimentary consciousness of the distinction between the general and the particular, the "class" and its constituent members. But how this has been attained Dr. Romanes's account of receptual ideation hardly helps us to understand.

The recept or generic image is the first of the psychological stepping-stones leading across the unfordable Rubicon, and it is also the principal stepping-stone. Should this prove to be unstable, the transit would certainly become exceedingly doubtful.

From the recept we pass to the concept, which, according to our author, is in its simplest form a named recept. The addition of the name or sign is thus the differentiating character of the concept. We may have generic images, but no concepts apart from names or other signs.

In order to understand how the concept is marked off from

the recept, we must accordingly inquire into the psychological conditions and concomitants of the naming process. And this our author does at some length. He gives us a full and detailed account of names and of signs in general, distinguishing different grades of sign-making from the merely indicative pointing or other gesture up to the bestowal of a general symbol with a consciousness of its significance as connoting certain common qualities. Into much of this it is not needful for us to follow Dr. Romanes, but brief reference may be made to one or two points of special importance as bearing on the evolution of the higher conceptual thought. One of the most curious features of Dr. Romanes's theory of concepts and naming is the proposition that the name is bestowed on the idea, and has for its psychological condition an act of introspection. He tells us that before we can bestow a name on a recept we must be able to set this recept before our mind as an object of our own thought. Or, to express the truth in the author's own words, self-consciousness is the necessary presupposition of naming and so of conceptual thought. Before I can name an idea I must reflect on the idea as mine, and before I can judge in the logical sense, I must realize the truth of the proposition as such, that is presumably as truth for me, so that self-consciousness would seem to come in necessarily at all stages of conceptual thought.

This doctrine seems by no means as clear and convincing as the author supposes. He is, as he clearly tells us, confining himself to the psychological treatment of his subject. This being so, it may fairly be urged that in making an act of subjective introspection an essential factor in the process of naming he is psychologically wrong. Is a child when inventing a name for his toy-horse or doll reflecting on his idea as his and naming this idea? Is he not rather thinking wholly about the object, and is not the name given to this external object and not to the idea in the namer's mind at all? * No doubt the completed process of logical reflection on names and propositions brings in the subjective element—that is to say the mind's consciousness of its ideas and judgments as representations of the realities thought about. But this reference to self, this act of introspection, so far from being involved in every act of conceptual thought, is directly excluded from it.

This brings one to the next point. In naming things the mind is busily occupied, not with itself and its ideas, but with the "not-self," the qualities and relations of the things perceived or rep-

* I believe that observers of children will indorse the remark that children regard names as objective realities mysteriously bound up with the things, and in a manner necessary to them. A nameless object is, for a child, something incomplete—almost uncanny.

resented. And this suggests first of all that naming, properly so called, only begins when things come to be apprehended as such, that is to say, as wholes or unities. And here the question occurs whether an animal, say a dog, that is just coming on to understand a name or two, as that of the baby of the house, can be said to have an organized percept precisely analogous to our own percepts? Dr. Romanes does not raise the question, but, in view of the light thrown by modern psychology on the complexity of the process of perception, it might not have been redundant. But waiving this point as possibly smacking of the frivolous, we have to ask whether an animal at the stage of mental development at which it appears to begin to understand names, and even to make use of them, is capable of carrying out the processes that go along with, and in fact constitute, naming in its true and complete sense. These processes have already been referred to in connection with the subject of general ideas. To name an object appears to mean to apprehend that object as a complex of qualities, to make mental separation of these, and so to relate it to other objects both by way of similarity (classification) and dissimilarity (individuation). To use a name intelligently at all would seem to imply that these processes have been carried out in a rough fashion at least. This being so, we must be prepared when we endow an animal with the power of naming, whether under the form of understanding or that of using names, to say that it is carrying out in a rudimentary way at least these thought-processes. How, it may be asked, does Dr. Romanes deal with this point?

The answer to this question will be found by turning to new distinctions or "stepping-stones" in the movement of thought-evolution. Our author attaches importance to the distinction between higher and lower forms of the concept. Not only is there the generic image to carry us on smoothly from image to concept, but within the limits of the concept itself there are higher and lower forms. Since, according to our author, a concept is any named idea, a proper understanding of these conceptual grades can only be obtained by a glance at his scheme of names.

There are, according to Dr. Romanes, four stadia in the evolution of the complete logical sign or general name. Of these the first is (*a*) the *indicative* sign—that is, a significant tone or gesture intentionally expressive of a mental state, as the characteristic tones by which animals express their emotions. These are not names at all. Next to these in the order of evolution come (*b*) *denotative* signs. These, whether used by children or animals, e. g., talking birds, simply mark "particular objects, qualities, and actions." They are learned by association, and are not consciously employed as names. By the use of such a sign the talking bird merely fixes a vocal mark to a particular object, quality,

or action; it does not extend the sign to any other similar objects, qualities, or actions of the same class; and therefore by its use of that sign does not really *connote* anything of the particular object, quality, or action which it *denotes*. Next in order (*c*) follow *connotative* signs which involve the "classificatory attribution of qualities to objects." This attribution of qualities may be effected either by a receptual or a properly conceptual mode of ideation. For example, a parrot had come to use a barking sound when a particular dog appeared on the scene. This sign was afterward extended to other dogs, showing that there was a certain recognition of the common qualities or attributes of the dog. Similarly when the writer's own child, among its first words, used the term star for all brightly shining objects. Here again there was perception of likeness, but no setting the term before its mind as an object of thought. Lastly (*d*), we have the *denominative* sign which means a connotative sign consciously bestowed as such with a full conceptual appreciation of its office and purpose as a name.

In this scheme Dr. Romanes evidently recognizes the point we are now dealing with, viz., the implication of a true thought-process in the proper use of a name. He seems to be trying to dispense with this as long as possible, with the view of securing a number of intermediate stepping-stones. Can he be said to have succeeded? Does this hierarchy of signs with its parallel scale of ideation carry us up to logical thought? Is it even intelligible? Let us briefly examine it.

To begin with, it staggers one not a little to find that long before the "classificatory attribution of qualities" is possible, the animal somehow manages to mark "particular qualities," whatever these may mean. How, one asks, can a sign be appended to a quality without becoming a "connotative sign"—that is, attributing a quality to a thing? But let us pass to the really important point, viz., the alleged power of the animal, e. g., the talking bird, to extend a sign to different members of a class, and so to attribute common qualities or resemblances to these, while it is unable to form a concept in the full sense. This extension, we are told, takes place in the case of the sign-using bird by receptual ideation. And here the critic may as well confess himself fairly beaten. On the one hand, Dr. Romanes tells us that such a named recept is a concept (lower concept), and, moreover, that the sign employed is a connotative sign; on the other hand, he hastens to assure us that it is not a name, and therefore presumably not a concept, in the rigorous or perfect sense, since the sign is not consciously employed as a sign. Here we seem to have a stepping-stone which it is impossible to define, a sort of *tertium quid* between the image and the concept which is at once neither and

both: Surely if a sound is used for the purpose of marking resemblances and attributing qualities, it is a genuine name, and the mental process underlying it is a germ of true conceptual thought. To say that the parrot attributes qualities, and attributes them in a "classificatory" way too, seems indeed to mean that the bird has got a considerable way along the conceptual path, and is fairly within sight of our distinctions of thing and quality, individual and class. Why logical reflection on this name as such should be needed to raise such a performance to the dignity of a true conceptual act, one is at a loss to understand. And, indeed, the author himself appears to recognize all this in a dim way at least, when he adds that the connotative sign may be the accompaniment *not only* of receptual but of truly conceptual ideation. At the same time this addition may very well complete the reader's perplexity, for it appears to render the next stage of evolution, the denominative sign, unnecessary.

Altogether the author's account of sign-accompanied ideation is not quite satisfactory. To begin with, one misses an adequate psychological treatment of signs in general, their nature and function in our mental processes, such as M. Taine has given us in the beginning of his work On Intelligence. Then our author has left us very much in the dark as to what it is that the sign does for the intellective process, when it begins to be used. On the one hand, since we are told that the mere addition of a name transforms the generic image into a "concept," we naturally expect the function of the sign to be a large and important one. On the other hand, we gather that signs can be used at the level of receptual ideation, where, consequently, true conceptual thought is wholly excluded.

This confusion seems to have its main source in the curious theory that while an idea may be general, it can not become a true concept till it is introspectively regarded as our idea; and its counterpart, that while a sign may be a true sign and even subserve the attribution of qualities to objects, it can not grow into the full stature of a name till it is reflected on as a name. By this doctrine Dr. Romanes seems unwittingly to have substituted the logical for the psychological definition of the concept, and so to have put the latter higher up in the evolutional scale than it ought to be. To this it must be added that the author appears to have been overanxious, with the view of making the transit smooth, to multiply distinctions. Such intermediate forms as Dr. Romanes here attempts to interpolate in the process of intellectual development can not in truth do away with the broad distinctions which psychologists are in the habit of drawing. Thus the recept only appears to connect the image and the concept just because it tries to be both at the same time. So the lower stadium

of the sign only gives an appearance of bridging over the interval between signless ideation and sign-aided thought, just because it aims at once at being something less than a true sign, and this true sign itself.

If our criticisms are just, Dr. Romanes can not be said to have succeeded in his main object, viz., the obliteration of all qualitative difference between human and animal intellection by the interposition of psychological links which can be seen to have the essential characters of both. And here one is naturally led to ask whether the author is after all on the right track. For he is a master of his facts and shows considerable power in the marshaling of his arguments, and, as even a hasty perusal of the volume can show anybody, he has here concentrated his force in a severe and sustained effort. Where he has failed it is conjecturable that others may fail also. And so it behooves us to see whether he has approached the problem in the right way, or, at least, in the only possible way.

The introduction of all this technical mechanism of receptual ideation, lower concepts, and the rest, has for its avowed object the avoidance of all introduction of qualitative change in the process of intellectual evolution. Dr. Romanes tells us plainly at the outset that he is going to establish identity of kind between the animal and the human type of intellection. And, no doubt, if it were possible to do this in the way here attempted—that is to say, by interposing transitional forms which virtually efface all qualitative unlikeness—it would be a great advantage to the evolutionist. But it may be said that it is not the only way of satisfying the requirements of the evolution hypothesis. Dr. Romanes pertinently remarks, in meeting *a priori* objections to the derivation of human from animal intellection, that in the life of the human individual we actually have a series of transitions from animal to human psychosis. Now, a glance at the intellectual development of the individual shows us that distinct qualitative differences are introduced. Not to speak of the obvious fact that every new sensation effects a qualitative addition to the infant's mental life, there is the more important fact that the first image of the absent mother or nurse introduces a new sphere of mental activity. The child that dreams and imagines is already a different being from the infant that merely touches and sees. Similarly it may be said that the first conscious process of breaking up its sense-presentations, the first distinct apprehension of relations, is epoch-making just because it marks the oncoming of a new mode of mental activity, a qualitative extension of its conscious life.

To say this, however, is not to say that the process of development is wanting in continuity. For, first of all, these higher forms of activity introduce themselves in the most gradual way,

and only slowly disentangle themselves from the lower forms which constitute their matrix. Thus the image little by little lifts itself butterfly-like out of its chrysalis, the percept. Similarly, what we call thinking, with its conscious comparing and relating of the products of sense-perception, emerges in the most gradual way out of lower forms of psychosis.

But this is not all, or the main thing. While the higher and lower forms of intellection undoubtedly exhibit qualitative differences, it may be possible to transcend these differences by going deeper, and detecting the veritable elements of the intellective process. This deeper analysis is emphatically the work of modern psychology, and, as every reader of Mr. Herbert Spencer knows, is of vast assistance to the evolutionist in following the psychical process from its rudest conceivable form in the lower grades of animal life up to the highest achievements of human thought. The luminous idea that all intelligence is at bottom a combination of two elementary processes, differentiation and integration, seems to lift one at once high above the perplexities with which our author so laboriously deals. It enables us to say that animal intelligence, just because it is intelligence, must be identical in substance with our own. The qualitative differences between perception and conception, or, to take Dr. Romanes's example, "the logic of recepts" and the logic of concepts, which obstinately persist so long as we look at the process *ab extra*, now appear as mere results of different degrees of complexity, of unlike modes of combination of the ultimate elements; just as to the physiologist the manifold variety of color resolves itself into different modes of combination of two or three elementary sentient processes.

When once this fundamental identity of all intellective processes is clearly apprehended, the question where exactly in the evolutionist's tree the twig of thought proper, or better, perhaps, of conscious generalization, branches off, sinks to its proper place as a question of quite secondary importance. At the same time we may agree with Dr. Romanes that the point has its real historical or genealogical interest, and that he has not done amiss to devote a volume to its discussion.

The question turns mainly on the point how much the animal can do by means of pure imagining and the aid of association. Our author clearly recognizes that this will carry animals some way, and may give to their mental operations the appearance of a true generalizing process. But he has not fixed the limits of this pictorial or suggestive inference with the precision one looks for, partly, no doubt, because his whole view of the generic image as somehow involving a generalizing process tended to obscure from him the real point. One might safely, perhaps, hazard the assertion that the diving-bird can get on very well without any-

thing like a general idea of water, a pure (generic) image being all that seems necessary. On the other hand, one is disposed, on the evidence of the facts adduced by our author, to put the beginnings of the true generalizing process pretty low down. It certainly seems to be involved in the mental life of the ants, as elicited by Sir John Lubbock's experiments, and described by Dr. Romanes (p. 94 and following). And since these particular actions plainly imply the use of signs, and apparently signs capable of indicating such abstract ideas as those of quantity, there seems no reason why we should hesitate to call ants thinkers in the sense of being able to form general notions. The same applies to the mechanical inventions of the spider, described by Mr. Larkin (p. 62). Similarly, it is difficult to deny the rudiment of "conceptual thought" to a fox who can reason on the matter of traps in the way described by Leroy (p. 56), or to a dog that was cured of his dread of imagined thunder by being shown the true *cause* of the disturbing noise, viz., the shooting bags of apples on to a floor (pp. 59, 60). No doubt there is a danger in straightway endowing animals with mental qualities identical with our own, when their actions resemble ours. There may, of course, be two psychological explanations of the same action. We can not, however, escape our limitations, and, if we are to deal with animal ways at all, we are bound to interpret them in terms of our own mental processes.

The hesitation of the evolutionist to attribute rudimentary thought to animals, in which Dr. Romanes evidently shares, is no doubt due to the firmly established assumption that we generalize by help of language. To the nominalist more especially it savors of rank heresy to hint that animals apparently destitute of signs may be capable of generalizing their perceptions and reaching a dim consciousness of the distinction between the universal and the particular.

But is the nominalist's assumption that language is the indispensable instrument of thought above challenge? A considerable part of Dr. Romanes's volume deals with the relations of thought to language. He gives us a fairly good summary of the results of research into the origin of language. It can not be said that these throw much light on the question. Perhaps it is unreasonable to expect that they should. Our author contends with some skill as against Prof. Max Müller that the earliest traces of human language suggest a highly pictorial and non-conceptual mode of ideation. And in his ingenious hypothetical account of the genealogy of man as the articulate reasoner our author inclines to the idea that, so far from language making the thinker, the endowment of language has to be ingrafted on a high quality of intelligence, and even then to undergo considerable development before it becomes a mechanism for conceptual thought.

The whole subject is still a dark and perplexing one, and we must refrain from dogmatizing. It may, however, be contended that the evidence on the whole supports the view that the generalizing process is up to a certain and not very high point independent of language. That is to say, an animal unassisted by any system of general signs may make a start along the path of comparing its observations, resolving them into their constituents, and separating out some of these as common qualities. Whether in these nascent operations of thought there is some substitute for our mechanism of signs, we do not know and perhaps never shall know. However this be, they remain nascent processes never rising above a certain level. The addition of some kind of sign which can be used as a mark of common features or qualities seems to be indispensable to any high degree of generalization, and to any elaborate process of reasoning. It is the want of such signs, and not the lack of the "power of abstraction," that keeps certain animals, for example the dog, from being rational animals in as complete a sense as a large number of our own species.—*Nineteenth Century.*

AN EXPERIMENT IN EDUCATION.

BY MARY ALLING ABER.

SECOND PAPER.

ENGLEWOOD, Ill., is now a portion of the city of Chicago; but formerly it was a suburban town with an independent school system. In October, 1886, Miss Frances MacChesney, a primary teacher in the Lewis School, obtained permission from her principal, Miss Katherine Starr Kellogg, and her superintendent, Mr. Orville T. Bright, to try some work on the lines wrought out in the experiment made at Boston.* Her request was granted, on condition that she would complete the grade work in the required time.

At first nothing was attempted beyond the giving of simple science lessons as bases for reading lessons. In these the children were furnished with specimens, and led through their own observations to the acquisition of facts and ideas, which the children expressed; these expressions put upon the blackboards constituted the reading matter, and were written in script or print on slips of paper for further use. At this time Miss MacChesney herself thought of the work mainly as a more interesting way of teaching reading; and, although the basal lessons were usually drawn from Nature, little attention was paid to the quality and value of the

* See this Monthly for January.

ideas thus used. Later, the fundamental idea of the Boston experiment was taken up, and the chief attention directed to the selection of topics and materials for real science lessons.

In this work no effort was made to introduce the vocabulary of the reader assigned to the grade. In February that reader—Appletons' First—was given to the children for the first time. To quote Miss MacChesney's own words: "The interest which had been awakened by the reading of their own thoughts was transferred to the books, and the grade work was completed before the required time—thus more than fulfilling the condition on which the trial was allowed to be made."

The work in reading went on in this manner during a second year, all other grade work being done in the old ways. During the third year systematic lessons on minerals and plants were given, and work in literature begun; and the children's sentences were written out on a typewriter. In a letter written at the close of this year, Miss MacChesney says: "Out of a room of forty children, divided equally into two classes, one class finished the first year's work in eight months; the other class, with the exception of two children, completed the grade work at the end of the year, besides doing all the extra work; and the whole was accomplished with ease and happiness on the part of both pupils and teacher." During the first year of trial, another teacher in the Lewis School, Miss Quackenbush, became interested in Miss MacChesney's work, and began a similar attempt with her own class. In a short time she produced excellent results.

From the first, Mr. Bright carefully watched the progress of the trial, and willingly and patiently waited its results. When convinced of the superiority of the principles involved and of the results obtained, he earnestly championed the cause, and has continued to be its enthusiastic supporter.

During the second year, teachers' meetings were called, discussions aroused, illustrative lessons given, courses of lectures for the teachers projected, and other teachers joined in the work. A teacher wrote me at the time: "I never saw teachers so ready and eager to 'speak in meeting'; . . . I never saw them so thoroughly awake." Finally the principals and teachers of the Englewood schools generally waked up to the fact that something new and interesting was going on in their midst; the idea spread, and many visitors came from adjoining towns.*

* In the fall of 1888 Miss MacChesney gave a series of lessons on grasshoppers and beetles. These the children caught for themselves, but she herself killed and preserved them in alcohol. The following summer, while teaching at an institute, she was attacked quite fiercely for this part of her work, on the plea that it was inculcating cruelty. I should like to ask all who bring this plea whether they eschew roast beef for dinner. Shall a million beasts of a high grade of intelligence and finely wrought nervous systems daily wit-

At the beginning of the fourth year a printing-press was provided; but each teacher furnished her own type, set it, and did the printing for her class. During this year, after four months of the new work, one division of Miss MacChesney's class "completed the grade work in reading in three months, a thing never before done at Englewood." Concerning this year Miss MacChesney says further; "From the experience which this year has brought me, I am thoroughly convinced that, could the average child have from the first the results of his own observations put in printed form, and enough of phonics to enable him to find out new words, the reader could be withheld until the latter part of the year, when it would be read with relish, and as a book ought to be read. . . . The power gained by the children to observe closely, to tell clearly and concisely what they have observed, and the power of logical, connected thinking is not confined to their science and reading, but is felt in all the work of the schoolroom. . . . In looking back over the time since we began working out this theory, I see a constant increase in the power of the classes that have been led along this path."

In regard to the influence of this work upon herself, Miss MacChesney, during the third year, wrote me, "At night I can hardly wait the morning, so eager am I to begin another day, and see how the children will go through the work planned for that day." Here she reaches the true work of the teacher—to watch and direct the growth of the children's minds. From letters received from Miss MacChesney during 1889–'90 I cull the following: "I started out to try what seemed a theory of doubtful utility to public-school children, and found all my work and my life enlarged and beautified. . . . I am certainly happier than I have ever before been in teaching, and I know I am doing more for the children intrusted to my care. . . . Mr. Bright, in order to speak with assurance about these matters, visited fifteen city teachers; and in no case did he find the attention of teachers or children directed to anything but the symbol, and in no case were the children further advanced than ours where thought and symbol go hand in hand. . . . I did not meet with any opposition in the work. The only requirement that I must meet was 'the grade work

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ness the scenes in ten thousand slaughter-houses, and themselves be the victims of the loathsome indifference to cruelty there practiced—shall this exist and pass uncondemned, because its results are pleasant to the appetite of the body, and the cry of cruelty be raised when a few hundred grasshoppers are killed for purposes of study? Is the body of more value than the mind, and nourishment more desirable than knowledge? So long as slaughter-houses exist, so long will it seem desirable to teach children reverence for animal life by minute personal study of the wonder and beauty of organ and function in the lower forms. When slaughter-houses have been done away with forever, the human mind will find a better way to teach zoölogy. Let the cry of cruelty go forth, but not from those whose own flesh is built up from the flesh of their brute brethren.

accomplished in the required time'; and whether I could do that was asked over and over again. . . . The greatest trouble" (referring to the days before they had a printing-press) "was the lack of printed matter. I met no criticism from parents and much praise. Especially was this true of the work in literature. . . . The criticism oftenest given by visiting teachers is on the 'big words,' as they call them." Elsewhere, in regard to these "big words," she says: "They" (the children) "were proud of their new possessions, and lost no opportunity to use them and use them correctly. The so-called 'big words,' when they express a definite idea, are remembered with ease, while their humbler sisters which express nothing tangible are more readily forgotten. . . . We can say emphatically that the work can be done in the public schools, and that both teachers and pupils are benefited thereby."

Another Englewood teacher wrote me: "The teacher gains an impetus in searching for and assimilating real truth to give to the waiting little ones. . . . I believe the parents of our children are becoming awakened, for children tell me of searches made at home to answer whys and hows, whens and wheres, that have been raised in the work at school."

Miss Walter, critic teacher at the Oswego (New York) State Normal School, after a visit to Englewood in February, 1890, wrote me: "It has been my good fortune to see within the last week some of the best school work I have ever seen. . . . It was in the rooms of Miss MacChesney, Miss Quackenbush, and others that I saw such admirable work. . . . Miss MacChesney is carrying out, in a wise and careful manner, an ideal line of work."

In closing this account of the new work at Englewood I can not do better than to give quotations from two letters received from Mr. Orville T. Bright, the superintendent under whom all this experimental work has been done. He says:

December 15, 1889.—"We are now harder than ever at work studying how to make observation a living element in our schools. . . . We have thirty—yes, forty teachers now who are thoroughly in earnest in the matter."

March 9, 1890.—"It is about three years since Miss MacChesney began the work. Miss Quackenbush soon followed, and the next year Miss Phelps, all in the Lewis School; . . . and the fact was demonstrated beyond a doubt that fifty children are no bar to the success of a teacher in training little children to observe in subjects pertaining to science.

"All our primary teachers slowly wheeled into line. We had numerous meetings and discussions on the subject, and every one who tried the work was convinced. The stand of the superintendent had been misunderstood from the first, but he did not think it wise to force matters. He wished teachers to undertake

the work because they believed in it; and now every first and second grade teacher in the district—thirty-five in number—are in hearty sympathy, as are almost all of the third and fourth grade teachers, about sixty in all. Not all, however, are at work.

"There has been no systematic arrangement of material, only so far as individual teachers have made it in a small way. Our aim has been to demonstrate the feasibility of doing the work with large classes, and to prove the growth of children under the training possible. These two things we have done; and we are now at work upon a related plan for the several grades. The scheme must be a flexible one, and it can be so arranged; but the second grade work must grow out of and be an advance upon the first, and so on. We have discussed *motive* first for several weeks. Now we are on material; then will come method. These I can not write about now. We hope to see the subject in some kind of shape before the end of the school year."

Do not the results of the trials at Boston and Englewood virtually constitute a plea to parents and teachers to investigate this matter—not necessarily to follow, but possibly to get suggestions about a better way; for the contemplation of a new thing sincerely conceived sometimes leads to the inspiration of a better?

Pupils in all sorts of schools seem, for the most part, unable to distinguish between opinion and fact; their reasoning processes are easily overturned, imperfect, slovenly; their power to discriminate values is slight; and the whole working of their minds lacks cohesion, totality, and gradation. Is not the human mind naturally capable of trustworthy action, and is not the lack of such action in the average adult due to faulty education? To see clearly, judge fairly, and will strongly—are not these the great ends of education? Should not a man have as great a consciousness of mind and of power to think as he has of hands and feet and power to use them; and should he not be as unerring in the right use of the one as of the others? Should not the schools give this consciousness and power and mental skill; and also fill the mind with ideas worth the effort of getting and retaining?

The maxim, "Ideas before words," adopted by teachers like Prof. Louis Agassiz, has produced great results in changing the methods of study in the natural and physical sciences. This influence has extended to other departments in the older centers of learning, but the majority of our higher schools are yet scarcely touched by it. In these, study results in little more than filling the mind with words; and from them students pass into life without the taste or ability to examine and estimate facts, and to form independent judgments and volitions.

In primary education the maxim "Ideas before words" is re-

peated with tiresome iteration, but seldom is a question raised about the value of the ideas taught. Do the charts and books for primaries express aught that is unfamiliar to children? Rather do they not contend for the merit of expressing most completely the commonplaces of child-life? Is there anything worthy to be called thinking or capable of arousing interest and emotion in memorizing combinations of symbols, and associating them with familiar and trivial ideas? And let us see what "object-lessons" chiefly deal with. Last year, in a normal school of the Empire State, a teacher of primary methods, proudly claimed by her principal to be the best in the State, gave thimbles, scissors, chairs, etc., as suitable subjects for object-lessons, and carefully led her pupils through the steps required to develop in children's minds ideas of the parts and the uses of these objects. Is there one child in five hundred, at six years of age, ignorant of these parts and uses? Then the so-called development process is a farce, and a waste of time and energy. Look over manuals of object-lessons and courses of study for primary children: you will usually find but few subjects leading the child from the beaten path of his daily life into new, inviting, and fruitful fields; and of these, note the directions as to what is to be taught. Such directions often resemble a lesson on a butterfly that I heard given by a kindergartner. With a single butterfly held in her hand she led the children to speak of its flying in the sunshine, sipping food from flowers, living through the summer, and of the beauty of its colors. Not a word was said of the three parts of the body, the two pairs of wings, the six legs, the antennæ, and the tube through which it sips food—all of which and more the children could easily have been led to see. Doubtless the teacher thought the children had had a beautiful lesson; but had they received anything at all? Although city children, they spent the summer in the country—they had all seen and probably chased several species of butterflies, and possibly some of them knew more than their teacher about the habits of butterflies.

Think of children gathered by fifties in thousands of school-rooms, spending the first years of school-life in repeating *trivial facts and ideas that have been familiar from babyhood;* in learning the symbols for these ideas, and in counting beans and bits of chalk! The five-year-old boy who described a kindergarten as "the place where they are always pretending to do something and never doing it," and the eight-year-old girl who, after reading the first few paragraphs of some ordinary primary reading matter, looked up at her teacher and said, "I think these sentences are very silly, don't you?" are not alone in preferring the lessons of the street and the field to those of the school-room. In such dealing with trite ideas the child gets little mental exercise, gets

no addition to his knowledge save the written and printed symbols, gets no increase to his vocabulary, and little facility in using it. For these slight gains he gives the freshest, best years of life, and exhausts in weariness of spirit the fountains of intellectual interest and enthusiasm.

In the experiment an effort was made to bring the child at once into contact with the real substance of education. It is this concentration of attention upon the subject-matter, not upon the method of teaching it; on the kind of ideas, not upon the symbols of ideas, that chiefly differentiates this experiment from ordinary primary work, and makes the use of the word experiment legitimate. The value of method is heartily conceded, but what shall be taught was thought to be of more importance. Is it not a law of Nature that new and valuable ideas only can arouse interest and lead to worthy thoughts? When such thoughts exercise the mind, do they not exclude the transient and trivial, lead to culture and right conduct, and so further the true end of existence—the perfectionment of the soul?

Do not the showy, the superficial, the transient, the seeming, rule the hour? Where do we find the heroic dignity that should inhere in man and woman? Few pursue truth and righteousness for their own sakes regardless of consequences; in few does the love of humanity overcome the shrinking from poverty and calumny. Are we becoming a nation of cowards and infidels, that we can fear nothing but material and intellectual discomforts in this one short life?

To awaken love for great literature, to arouse interest in local history, to develop a habit of observing Nature's phenomena—to do these before the mind has sunk itself in materialism and the love of sensual delights—to do these while the child is still so young that mind and heart are plastic and responsive, is indelibly to impress the idea that these are the legitimate objects of study whose pursuit leads, not to learning only, but to nobility of mind, and to real, satisfying pleasures. One can not know and love the great in the world's literature and not be ashamed of mean thoughts; one can not be a student of history without bringing to bear upon the affairs of our own time a greater intelligence than the majority of our politicians exhibit; one can not habitually observe Nature's phenomena without extending that habit to the highest and most interesting of her creatures—man; and one can not observe man, with any depth of insight, without being profoundly impressed, not alone by the miseries of the very poor and the never-ending drudgery of the laboring classes, but by the lack of unselfish zeal, heroism, dignity, truth, gentleness, generosity, and purity among the well-to-do; one can hardly view the course of Nature and history from remote ages to the present

without seeing through all a tendency to completion, order, and beauty on an ever-rising plane, like the threads of a spiral; and, seeing this, to desire to be himself in harmony with that tendency and a factor in aiding it in his own time.

I put forth no claim to the Boston experiment or the Englewood trial as a cure for existing evils; but I urge every educator who loves mankind to investigate each new departure in education, to test any that seems to have good in it, to cease to concentrate attention on symbols and shows, and to turn thought to such realities as can nourish the mind and heart, and be retained as valuable furnishings for all the years to come, and to do these from the first day in the primary school.

[*Concluded.*]

HOMELY GYMNASTICS.

By ALICE B. TWEEDY.

WHILE voyaging over many seas of experiment in search of education, some of us are beginning to apprehend that the golden fleece of mental culture will not create for us the symmetrical man or woman. As a consequence, various systems of bodily training are receiving close attention from teachers and reformers, while athletic sports are now honored and encouraged in schools and colleges where not many years ago they were merely tolerated as safety-valves for unsubdued vitality. We are returning to Greek ideals, but the elimination of the mediæval and Puritanic expression of contempt for the body is a slow process, and the formula still meets us variously masked in life and literature. Now, it is the notion of the spiritualizing effect of invalidism, or delicacy of health; their debasing tendencies toward selfishness and morbidity being ignored. Again, it is the exaltation of nerve sensitiveness into an evidence of refinement; forgetting that the healthy nerve, like the pure metal, stands the normal test put upon it, the flinching being a token of failure as the alloy is of gold. In another instance, it is the scorn for manual labor, although this indicates also the survival of feudal feeling. We call the hand the servant of the mind, thinking we have ranked it, but educating the blind shows us that it may turn instructor and incite its ignorant master to action.

This is an age of fads and fetiches, and, as we give up our idol of disembodied intellect, we erect a shrine to meaningless muscle. We have outgrown croquet and archery. Even tennis no longer suffices, and we are founding schools of physical culture and gymnasiums *ad libitum*. In truth, these are needed badly enough

by the physically idle, and if strength of body is our aim, a beginning must be made somewhere in its training. Does it not savor, however, of absurdity that the girls, who not long since were frowned upon for being "tom-boys"—i. e., using their muscles in running and jumping—and afterward were cautioned against running up and down stairs or taking long walks, should be suddenly precipitated upon parallel bars and turning poles, where there is emulation and a slight danger of overdoing? Very far am I from believing in any inherent physical frailty of women, or that it is not good for a girl to turn a somersault or learn hand over hand. It is the inconsistency of such philosophy that calls for comment.

Unquestionably the best exercise is that taken in the open air; and rowing, running, walking, skating, horseback-riding, have forever the advantage over indoor training, in that they oxidize the blood as well as develop muscle. Gymnastics, on the other hand, has two special claims—economy of time and defiance of weather. But it is not only to the gymnasiums, equipped with apparatus and superintended by doctor or professor, that we need betake ourselves if muscular development is our object. These are attractive, and have advocates enough. Within our doors there is a despised sort of gymnastics which has few scholars, fewer teachers, and stands in great need of intelligent attention. The evangel of cookery has been preached to us from all quarters, but what missionary has been bold enough to proclaim the use and dignity of house-work?

"Nothing menial for me!" cries the ignorant woman; while her more intellectual sister exclaims, "Oh, I feel above such drudgery!" Alas! to what giddy heights must those minds be elevated which do not see the necessity nor compensation of muscular work! Mr. Gladstone can find refreshment for his brain in chopping trees, and an eminent jurist of the United States in vigorously plying the saw; but there are women so highly refined that they can no longer employ their muscles for any useful purpose.

In the pretty allegory of Homely and Comely, Moncure D. Conway contrasts for us two common mistakes, neglect of housework and exclusive devotion to it, but shows also a health and beauty balance on the side of Homely.

That there is not much sanitary or strengthening influence in the operation of dusting is evident; and yet many women, disdaining heavier work, reserve this domestic duty for themselves and waste much time upon it. Muscular motion is of little value unless vigorous and swift. The slow walk and loitering movement do not rouse the blood from its torpidity. The lowliest labor when zealously performed may be followed by an unex-

pected hygienic effect. There is the instance of a penniless young man, threatened with fever in a strange country, shipping as a deck-hand to return and die among his people. During the voyage he scrubbed away the dirt from the ship-boards, and with it the disease that had invaded his life-craft. A story is also told of a family whose women were of the delicate, ailing sort. Misfortune obliged them to perform their own domestic work. What seemed for them a sad necessity proved itself a double blessing. They gained what they had never known before, robust health; and their enforced economy restored them to a prosperous condition.

Not all physicians are clear-sighted or independent enough to prescribe as did one of their number. A young lady supposed to be suffering with anæmia, nervous prostration, and other fashionable ills sent for the family doctor. "Is there anything I can do to get well?" she asked, after the usual questioning. "There is," answered he; "follow this prescription faithfully." The folded scrap of paper read as follows:

"One broom: use in two hours of house-work daily."

That domestic work is not without its æsthetic side many authors bear witness. George Eliot introduces us to Hetty Sorrel at the butter-making, and writes, "They are the prettiest attitudes and movements into which a pretty girl is thrown." But if dairy-work is rapidly taking a place beside spinning and weaving as one of the picturesque employments of the past, what there is to do about the house may be also gracefully done. And here, it may be said of this as of all other work, the spirit and care we put into it endow it with beauty as well as health.

Aside from the physical view of homely gymnastics, there is a social and an economic aspect. Courtship need not wait upon a problematic income if the fair Dorothea has not only a clear head but arms willing to take up the burden of life equally. Does Hermann need to toil? She deems it incumbent upon her, unless busy with young children, to earn her own living within the home or outside of it. When women shall have been educated to a keener sense of justice, they will no longer imagine they have discharged their debt to the community by adding a few beautifying touches to the household furniture! Nor, although they fulfill the higher and more exacting duties of a mother, will they thenceforth fold their hands and do nothing. To be a good father does not absolve a man from work, neither does being a good mother exempt a woman from her share in the maintenance of the home. The maiden of to-day is yet enslaved by caste culture; but the maiden of to-morrow may scorn to be merely ornamental or useless. She may be too proud to allow her husband to support her in idleness and may refuse to be re-enforced by a

Biddy or Gretchen unless there is more to do than one pair of hands can accomplish.

The practice of these domestic exercises has also an important influence upon household service. The mistress who understands all the work required by her, and performs part of it herself, rarely has any trouble with servants. But, in order to attain this result, she must know more than the manner in which any piece of work is to be done; she must know how long it takes to do it, and in order to estimate this justly she will need to make practical trial of it herself without assistance. The knowledge and skill she gains in this way will also enable her often to suggest an easier method or better arrangement of work. The ridiculous requirements made in some households where there is a lack of service, and which result in frequent changes, would not be possible if the mistress had learned this lesson in its entirety.

Can it be repeated too often that it is the sign of ignorance to scorn any work well done, or the doer of it? Only when the dignity and importance of labor are rightly estimated can we hope for any well-founded social prosperity. While it is not suggested that wealthy women should discharge their servants and undertake their own domestic work, it may be urged that only good can come from their personal performance of some share of it—physical benefit to themselves and a more wholesome feeling for the labor of their necessitous sisters. Between the small minority who suffer from too easy living and those whose days are overburdened with care, there exists, especially in cities, a large class of women in moderate circumstances whose health would be greatly benefited by more physical exercise. These need not rashly bestride the bicycle, nor rush through the non-productive drill of the gymnasium as an only means of grace. They may garner their resources, develop their muscles in walking and in reconquering a world of flexibility and strength which lies within their own thresholds.

New evidence of the existence of a vibration or some other motion of change in latitude was presented to the American Association by Prof. C. L. Doolittle, who describes the results of between eleven and twelve thousand observations, made during the last fourteen years, at the Sayre Observatory, Bethlehem, Pa., showing that such variations were recorded. Prof. George C. Comstock, of Washington Observatory, Madison, Wis., deduced from similar observations at Königsberg, Pulkowa, Washington, and Madison, a theory that the north pole is moving along the meridian at the rate of four and five tenths of a second per century. The active discussion that followed the reading of these papers is an indication of the interest that is taken by men of science in a subject that has only recently begun to attract attention.

NEW OBSERVATIONS ON THE LANGUAGE OF ANIMALS.

By M. De LACAZE DUTHIERS,
OF THE INSTITUTE OF FRANCE.

I HAD occasion, in a note published several years ago in the Revue Scientifique, to mention a parroquet which I have since continued to observe, the manifestations of whose intelligence are both interesting and instructive. Many acts of birds are difficult of interpretation. To speak only of their songs, the meanings of most of the innumerable varieties of sounds which they produce, and of their diverse warblings, escape us completely. It is not possible to find the meaning of these things except by forming suppositions and hypotheses, or by catching the connections between cries and acts. But instances of the latter kind are extremely rare in comparison with the great majority of the manifestations made by animals.

Thus, to select examples which every one can observe, when a canary-bird is warbling in its cage and becomes deafening, or when a lark rises straight up in the air and *incantat suum tirile tirile*—sings its *tirile tirile*—as Linnæus picturesquely expresses it; when a tomtit, leaping from branch to branch of a willow or among the reeds, repeats its florid warblings; when a raven croaks; when a blackbird whistles—what significance can we attach to their songs and their cries? Certainty is impossible, and we can only form more or less plausible hypotheses concerning the interpretation of them.

The parrot furnishes us one more aid in this matter than other birds, and this helps us, to a certain extent, in overcoming the difficulty of interpretation. It has an articulate voice, and when we have taught it a few words, the meaning which it gives them may be better divined by us according to the tone and the rapidity or slowness of its utterance. This permits us to discover the feelings that move it, for we can better judge from an articulate sound than from one that is merely musical.

Much has been written on the language of animals. It is neither my desire nor my intention to repeat here all that may have been said on this subject. It would take too long and would be of no use. I have often witnessed facts that may be of interest to those who are occupied with the mental manifestations of animals. I will simply relate them; and of such as are already known, I will merely mention them anew, admitting in advance a priority for others which I do not demand for myself.

There can be no doubt that animals communicate their impres-

sions by an inarticulate voice. Common sense and the most superficial observations are opposed to the negative of this proposition. But when a canary-bird warbles till it stuns us, or a nightingale sings in the shadows on the fine nights of June, can we follow and discover the significance of those modulations—now sharply cadenced, now slowly drawn out, and ending with a trill long and accurate enough to challenge the most skillful musician?

All the poets of every country have constantly sung of the songs of Philomela. But their fervent and enthusiastic verses cast little light on the value of the nightingale's song. It is said that the male sings for the entertainment of the sitting female, but there is no proof of the assertion. The note warning of the approach of danger is easier to recognize. The bird utters a short, hoarse cry, and repeats it with a succession of *trrre, trrre*, which is impossible to mistake. When we hear this cry we may be sure that an enemy is near. Music gives way to a cry of distress and warning, and the female leaves her nest if the sounds become piercing. What do we know of the gobbling of the turkey, which the whistling and the cries of children excite? They are doubtless responses to those challenges; but what do they mean?

The crowing of the cock, recurring regularly at fixed hours, has some signification, but we can not comprehend it. If on a fine afternoon in autumn the cock crows, and repeats his strain between two and four o'clock, the countrymen in some places will say there will be a fog on the morrow, and they are generally not mistaken. Hens do not mistake his notes either; when a leader of the troop, coming upon a spot rich in food, utters his peculiar chuckle, they run from all around to share the find with him. It is evident that the cock has called them and they have understood him. These facts indicate that there is some definite sense in this inarticulate language; and examples of it, taken from other groups, might be multiplied.

The dog, intelligent animal as he is, manifests his affection on meeting his master, with peculiar cries which vary with the intensity of his joy. No one could confound these notes of pleasure with those which he utters when he is angrily driving away a beggar, or when he meets another dog of unpleasant appearance and puts himself in the position of attack.

An interesting study of the voice of the dog on guard may be made in the country at night. If another dog barks in the distance, the house-dog answers in a peculiar manner. He gives a few growls, stops, seems to listen, begins again, very often getting answers; and, after two or three interruptions, he terminates his barking with abrupt yelps, loud at the beginning and long drawn out, and gradually dying away. This ending of his cries is habit-

ually accompanied by his raising his head and throwing it back. I have often, when within the house, on hearing the watch-dog bark in this way, opened the window to assure myself on the subject, and distinguished, as I could not do with the windows closed, the voice of another watch-dog barking in the same way in the distance—the barkings of the two dogs alternating, one answering the other. There is in such cases an evident communication of impressions. One of the dogs, having had his attention aroused by some unusual noise, has transmitted his impression to the other, as sentinels posted at intervals call out their warnings one to another. I have often repeated this observation during the long evenings of winter.

Another example, little known in thickly populated countries, is drawn from a curious scene which I witnessed during a winter passed in Perigord Noir. We had remarked that for several nights the three watch-dogs, a young and an old male and a bitch, howled often toward midnight, but in a peculiar way. One night in particular, during their tedious concert, just as we had got to sleep, they mingled with their cries howlings like those they would have uttered if they had been beaten, with a shading hard to define, but which we perceived plainly; and we remarked that, leaving their kennel in the avenue that led up to the lodge, they had come to close quarters with one another at the gate, with alternating howlings and plaintive cries. Inquiring in the morning for the cause of these singular cries, the peasants told me that a wolf had passed, and predicted that it would return. They said, too, that a neighbor's hunting-bitch had disappeared, and its bones had been found in the fields near a wood. We were awakened again about midnight by the cries of the dogs, and the scene was renewed. Informed as we now were of the nature of what was going on, we ran to one of the windows, whence we could see, in the clear light of the moon, all that passed. The three dogs were cowering against the gate, the oldest one howling by the side of the others, while the younger one and the bitch were exposed at intervals to the attacks of another animal, browner than they, and of about their size, without defending themselves, but moaning as if they were undergoing a vigorous correction.

Frightened, doubtless, by the opening of the blinds of the first story above him, the strange animal had gone away and was sitting in the middle of the road. We could only see that he had straight ears. While we were going down to get a gun the visitor came back to his charge on the dogs, which had begun howling after he left them, and resumed the cries significant of chastisement when they were attacked again. For some reason, perhaps because he heard the click of the gun, the foe drew back and sat down in a garden-walk, concealed by a bunch of shrub-

bery. The three dogs, notwithstanding our reiterated urging, were no more disposed to pursue him than before. If the assailant had been a dog they would have rushed upon him, but they stayed cowering at the gate and howled distressfully. The bitch was most affected, and they all seemed paralyzed by fear. It is said in the country that bitches are especially liable to be attacked by wolves. It was so here. The most certain feature in the matter was the terror of the animals. They were capable of resisting the attack three times over. The young dog was a savage one, and passers-by were afraid of the bitch; but that night they were terrorized, and all incapable of defending themselves. Their cries were therefore due to the same cause as in the preceding night—the presence and attacks of the wolf. I could not have realized their meaning if I had not been a witness of the scene—that is, I could not have correlated the cries and the acts.

A shot at the animal behind the bushes was followed by a hoarse cry. He was hit, and ran; but, in spite of our urgings, the dogs stayed at the gate and only stopped howling. Under any other conditions, upon the signal of the shot they would all have started in pursuit of the wounded animal.

A wolf came to the farm during the last winter (1890–'91) and attacked the same bitch. He would have carried her off, for he had seized her by the throat, if we could judge from the stifled cries she uttered; but this time he found with her a new watch-dog—a mountain bitch from the Pyrenees—of a breed that attacks the wolf and the bear. The wolf would have been caught if he had not run away. He did not return, for he had been attacked, and learned what he had to deal with.

The Pyrenean breed furnishes excellent watch-dogs. I knew one of remarkable traits. At evening he would go round the house, giving two or three growls at each door. With his head raised he seemed to listen to his fine voice, then he would start again and go to another door. He seemed desirous to show those who were observing him that he was attending to his post as guardian. He then went away in silence along the walk, through a dark, rising hedgerow, leaping the slight hillock, yelping, toward the wood. He listened, yelped again, and went in. There was never any failure in this performance, but every evening as night was coming on he began his round, which no one had taught him. It was all done in his function as a guard. It would be hard to determine what his yelps meant, but there were in them an inflection, a sonorousness, and a continuance quite different from those he uttered when pursuing a passer-by or when going to meet a person coming toward the house. Every one who has a watch-dog is able to tell by the sound of his barking when a person is coming up, and usually what sort of a visitor it is.

The peasants' dogs of the southwest of France dislike the country millers, because of the long whips which they are always carrying and snapping, and with which the dogs, running after them, are often struck. From as far off as the snapping of the whip can be heard, the dogs come to wait for the millers and pursue them; and it is easy to recognize when the millers are passing, by the behavior of the dogs. There is in this also a significance, at once aggressive and defensive, in the cries which one can, by giving a little attention, soon learn to distinguish.

Another example of the reality of the various meanings of the cries of the dog under different circumstances is afforded by the companies that collect around a female in heat.

I have a very intelligent and experienced brach-hound, the same which with the bitch had to face the attack of the wolf. He amuses me much at my country lunches. Hunting-dogs which have been much with their masters at lunch do not like to have the drinking-glass offered them. This dog was much afraid of the glass, and I had only to present it to him at lunch-time to make him keep his distance. I used to keep my door open at lunch, for the amusement of observing how I could make him stop exactly at the threshold without stepping over it. If he had passed over it I could always send him back by casting toward him a few drops of water from the bottom of the glass after drinking. Sitting, as was his habit, on the sill of the door, with the tip of his muzzle never extending beyond the plane of the panels, he would follow my motions with the closest attention, reminding me, if I failed to give him a sign of attention, by a discreet, plaintive cry, that he was there. But if I touched my glass he would spring up at once; if I filled it, he would put himself on guard, utter a kind of sigh, sneeze, lick his lips, yawn, and, shaking his ears briskly, make little stifled cries. Then he would grow impatient, and more and more watchful and nervous. When I lifted my glass to my lips he would draw back, working gradually nearer to the farther door, and at last disappear and hide. One who was looking at him without seeing me could tell by his wails and his attitude the level and position of my glass. When the glass was horizontal, I could see only about half of his head, with one eye regarding me fixedly, for that was usually the critical moment—the one, also, when the wails and restraints were most demonstrative of the anxious fear of my poor animal.

When we dine in the kitchen, which is on the ground floor, the dogs are usually all put out. There are four of them, three young and not experienced, and this old, sagacious brach-hound. He insists on coming in, and, to gain his purpose, tries to have the door opened. Although no person may be coming up the walk, he dashes down it barking, all the others going along too

and yelping with him; then he stops, remains a little behind after having got the others out of the way, and, turning his head from moment to moment, looks to see if the door has been opened, for we generally go to it to see who has come. In that case the feigned attack is successful, and the dog, who has evidently meant to give the alarm so as to have the door opened, comes in at once and claims a place at the table. He has accomplished his end, for the door is usually shut without paying attention to his having got in. I have frequently witnessed this stratagem, and when, during my kitchen dinner, I suddenly hear the dogs yelping after the brach-hound has begun, I am pretty sure that nobody is in sight.

I have forgotten where I found the next story of an old dog who was also very sagacious. Hunting-dogs, when they grow old, become rheumatic, or are at least debilitated with pains. We know, too, that they crave heat, and get as near the fire as possible—a craving which increases as they grow older. One such dog, older than the others, and slower in getting into the lodge on returning from the hunt, was often crowded away from the fire by the other livelier dogs getting all the best places before him. Finding himself thus turned out in the cold, he would dash toward the door barking, when the others, supposing it was an alarm, would rush away too, while the old rheumatic went to the fire and selected a place to suit him.

It is not necessary to dwell upon the intelligence shown by such acts. But it is hardly contestable that the old animal, who knows how to play such tricks upon his less experienced companions, deceives them by his intonations, while he is well aware that no enemy is approaching the house; but he does it scientifically, by the inflections of his voice, as a man speaking to other men would do in announcing the arrival of an imaginary enemy.

Inarticulate cries are all pretty much the same to us; their inflections, duration, pitch, abruptness, and prolongation alone can inform us of their purpose. But experience and close attention have shown us the connection of these variations with the acts that accompany or precede them. Animals evidently understand these inflections at once. We can not better compare the language of animals than with what takes place in a pleasant sport, a kind of pantomime of the voice or language which many youth doubtless understand, and which I venture to refer to here to aid in more easily conceiving of the communication of thought among animals by sounds which seem to us all alike. When I was engaged in hospitals, the evenings in the guard-room were sometimes enlivened by the presence of a companion who excelled in humorous mimicry. He would represent a man in liquor who had stopped at a fountain that flowed with a gentle

sound, somewhat like that of his own hiccough. A single oath, pronounced in different tones, was sufficient to enable us to comprehend all the impressions, all the states of mind through which this devotee of Bacchus passed. The oath, at first pronounced slowly and with an accent expressing relief, represented a feeling of satisfaction, with shadings of prolonged exclamation which it would be hard for one to imagine without suggestion. The continued flowing of the fountain made our drunken man impatient, and he wanted it to stop. This state of mind was translated by a new modulation of the same word. In a little while the gurgling of the fountain produced astonishment. Was it possible that he, with all the liquid he had imbibed, could vomit so much and for so long a time? This mental condition was expressed by a new modulation of the same oath. The first movement of surprise over, resignation follows, and our man decides to wait patiently for the end. A period of half lethargy was easily represented by the slowness and weakness of the man's voice while living up to this decision; but when he comes out of this sleepy condition and hears the fountain again, he is possessed with fear: he can not understand the flood he is pouring out—he dares not move—he believes he is lost. Gradually the fumes of the liquor pass away, and, his mistake being recognized, the drunkard is taken with a laughing and a gayety which are indicated by the same oath repeated in tones corresponding with the satisfaction he is then enjoying. This making the series of impressions a man passes through comprehensible by a single word, varied in pronunciation and utterance, is very like the language of animals, which is always the same, and the significance of which is given by variety of intonations corresponding with sensational conditions.

The mewing of the cat is always the same; but what a number of mental conditions it expresses! I had a kitten whose gambols and liveliness entertained me greatly. I understood well, when it came up to me mewing, what the sound meant: sometimes the kitten wanted to come up and sleep in my lap; at other times it was asking me to play with it. When, at my meals, it jumped on my knees, turned round, looked at me, and spoke in a coaxing and flattering way, it was asking for something to eat. When its mother came up with a mouse in her jaws, her muffled and low-toned mew informed the little one from a distance, and caused it to spring and run up to the game that was brought to it. The cry is always the same, but varied in the strength of the inflections and in its protraction, so as to represent the various states of mind with which my young animal is moved—just as it was with the drunken man in the mimicry scene. These facts are probably well known to all observers of animals.

We have seen that this tonality of the watch-dog's cries is

competent to indicate that a person is coming to the house. We find similar cries of warning uttered by birds. When I was a professor in the Faculty of Lille, I frequently visited the well-known aged Professor of Physics, M. Delezenne. He had a working-room at the end of a garden, in which a laughing mew wandered. From the time that any one came in till he went out, this bird made the vocal explosions to which it owes its name; and the good professor was certain, without ever being mistaken, that somebody was coming to his laboratory. He was notified. My Jaco in Paris has a warble that answers the ringing of the bell. If we have not heard the bell, we are notified by Jaco of its ringing, and, going to the door, find some one there. I have been told of a parrot belonging to the steward of a lyceum which had heard the words "Come in," when any one rang the bell. He never failed to cry, "Come in," when the bell moved, and the visitor was embarrassed at seeing nobody after having been invited to open the door.

Instances in which cries of birds had an incontestable and precise signification are numerous; let me refer to a few of the best known. The cackle of a hen, after having laid an egg and left her nest, is decidedly characteristic. Her clucking when she is impelled to sit on her eggs, or when she is calling her chicks, is no less demonstrative. There is not a farmer who does not recognize it and understand it. In these things we see the relation between the tone of the prating or cluck of the hen and her acts. But when a nightingale sings all night, or a gold-finch whistles or a raven croaks, we can not so easily interpret the significance of their inarticulate sounds. The finch calls its mate by uttering a few notes followed by a long trill. Matches, of a barbarous character based on this habit, were held in the north of France while I was living at Lille, between 1855 and 1860. I do not know whether they have been suppressed or not, but the laws for the protection of animals ought to take cognizance of them. The gamesters put out the eyes of the male finches, and made them, thus blinded, compete as singers, for which purpose they brought their cages into proximity. When the birds heard and recognized one another's voices, they made their appeal to the female; the one that renewed his amorous trills most frequently, protracted them longest and to the last, gained the prize. The bird that was declared victor received a medal amid the applause of a large and enthusiastic crowd; and considerable wagers were staked upon the result. I have heard that these poor blinded birds sometimes fell down exhausted with singing, and kept on calling the absent female till they died, not being willing to yield to a rival, who on his side was also keeping up his equally useless appeals. These finch contests were suggested

after the meaning of the song of the birds was learned. But when these birds, which are more usually isolated—whence they have been named *Fringilla cœlebs*, or celibates—hop around our houses and also utter their amorous trills at another than the mating season, they are evidently not calling the female. Should we not then seek to determine by the tone whether their call, which is always the same, is amorous or not?

In countries where flocks of turkeys are raised one can learn very quickly from their gobblings when they have captured a hare. If they meet him standing still or lying down, they form in a circle around him, and, putting their heads down, repeat continually their peculiar cries. The hare remains quiet, and it is sometimes possible to take him up, terrorized as he is in the midst of the black circle of gobbling beaks and heads. The language of the turkeys is at that time incontestably significant. It is war like, and similar to that of the males when they are fighting. In the present instance, they have joined for war, and they make it on the frightened hare.

My Jaco, like all parrots, which are excellent imitators, pronounces a few words and repeats them over and over again. Such birds amuse us, because the words they know sometimes happen to be ludicrously fitting. A bird of this kind had been struck by the note sounded by the wind blowing into a room through a crack in the glass-work whenever a certain door was opened; and he had become so perfect in his imitation that they sometimes, on hearing the noise, went to shut the door when it was not open. Jaco formerly belonged to a very pious old lady who was accustomed to say her litanies with another person. He had caught the words "Pray for us" in the invocations to the several saints, and said them so well as sometimes to deceive his learned mistress, and cause her to think she was saying her litanies with two colleagues. When Jaco was out of food, and any one passed by him, he would say, "My poor Cocotte!" or "My poor rat!" in an arch, mawkish, protracted tone that indicated very clearly what he wanted, and that his drinking-cup was empty. There was no doubt in the house as to his meaning; and whenever one heard it he said, "He has nothing to eat." He was exceedingly fond of fresh pits of apples and pears, and I was in the habit of collecting them and keeping them to give him. So, whenever, as I came near him, I put my hand into my pocket .he never failed to say, "Poor Cocco!" in a supplicating tone which it was impossible to mistake. A sugar-plum is a choice morsel to him. He can tell what it is from a distance when I hold it out in my fingers; and when I give it to him he can not restrain himself if it has been any considerable time since he has had the delicacy. Usually, after having made the first motion to get it,

as if he were ravished and wanted to express his joy in advance, he would draw back before taking it, and say, in a comical tone, "Hold, my poor Cocotte!" His manner of thanking in advance is likewise amusing. The expression of his eyes and the pose of his head are all in accord with the tone of his exclamation. When he tastes the plum he utters a series of *ahs*, and produces a kind of warble by prolonging some of his notes and shortening up others. We find in these examples without doubt that the articulate voice makes us better able to judge the meaning of the impressions that are moving the animal than inarticulate cries, or merely musical sounds. When Jaco met a child for whom he had a great affection, he would promenade on his perch, or turn the wheel, spreading out his tail and ruffling the feathers of his head, while his eyes grew red with excitement if the child was too slow in bestowing the accustomed caress. Then he would stop, bend down his head, and, looking at his friend, say pleasantly, "Jaco," in a tone and with a manner quite in contrast with the pronunciation of the same word when he was hungry.

It is not the word he speaks that is of interest; he might have been taught another, and it would have been the same; but it is the tone. In this case, too, the articulation gives an easier clew to the meaning the bird seeks to express, having a meaning according to the manner of pronouncing it, than any isolated, simply musical sound, like the song of the nightingale, canary-bird, and warbler. This became evident to me, not from observing animals for a few moments without seeing them again, but from studying them continuously.

Jaco did not like solitude, and was talkative and fond of being caressed, like all of his kind. One day when there was no one in the country-house, all having gone out into the garden or the fields, I heard him saying over what few words he knew, in different inflections. I went quietly into the room where he was, without being seen; but he heard my steps, although I had walked in very cautiously, hoping to surprise him. He ceased his chatter, listened, and, after a silence, pronounced "Jaco" in a low tone, drawing out the end of the word. He listened again, and repeated the word in the same tone; then, after another silence, repeated it with a rise of the voice I continued observing him, and, as he heard no one, he raised his tone gradually, repeating the same word, and ended at last with a genuine cry of distress. The people ran in from without, supposing something had happened to him. He then repeated his name in a lower tone, which seemed to indicate his satisfaction at finding his isolation ended. I went in myself, and his prattle unmistakably betrayed his gladness at being no longer alone.

Is there not in this an act of real intelligence? While alone,

the parrot entertained himself by talking; but when he heard a sound he hoped at first to see some one come; and when no one answered him, he raised his voice, as a person would do who calls, and, getting no reply, cried out louder and louder till he was heard and answered. The meaning of the differences of intonation is as evident in this case as in that of the drunken man. A parrot raised in the south had learned to swear in the local *patois*. Being fond of coffee, he was sometimes given a spoonful, which he would come awkwardly up to the table to drink with his master. One day the master, not thinking of his bird, had already added cognac to his coffee, and gave the parrot the accustomed spoonful. The parrot took a swallow of it, and, in his surprise at the novel taste, raised his head and repeated the oath in a tone that excited laughter in all who were present. The cause of his surprise being discovered, he was soothed, and then took his usual ration with evident signs of contentment. The mimicry of language in this case clearly represented the shade of the new impression he felt.

Jaco is very timid. In the evening, when he is put to roost in a close and dark room, he is afraid of the shadow of his perch that is cast by the light we carry in our hand; he eyes it, and utters a low cry, which stops when the candle is blown out and he can not see the shadow any longer. He stands in dread of blows in the bottom of his cage, because, having a wing broken, he can not fly, and is afraid of falling. Feeling his weakness, his language has a different tone from the usual one. Large birds flying in the sky above him annoy him greatly, and we can all tell by his voice when such a bird is near or flying over. He inclines his head and chatters in a low tone as long as the bird is in sight, paying no attention to anything else. Turkeys and hens announce the approach of a bird of prey in a similar manner.

We find in the facts which we have related, as well as in many others which are cited respecting the ways and habits of parrots, proofs of a remarkable intelligence. These creatures are distinguished by the unlimited affection which they bestow upon certain persons, as well as by their excessive dislikes, which nothing can explain. Jaco conceived an extraordinary dislike for a maid who, although she took good care of him, was in the habit of washing the bottom of his cage under a faucet. He afterward discarded another person, whom he had liked so much that she could do what she pleased with him, even to passing her hand over his back and taking him by the tail, holding him in her hands, or putting him in her apron—caresses of a kind that parrots do not usually permit. Nothing astonished him or offended him. He proved very inconstant toward her, and now, while better disposed toward the other girl, he is furious against this one.

A third miss has come to capture his affection; and when he has been left asleep, or resting in his cage, he has always the same word, but different in the inflection, wheedling, angry, or nearly indifferent, as either of the three persons comes near him. Jaco's pronunciation is scanned in many metres. Only one young student has had the privilege of retaining his affection unmarred.

Jaco had been left in the country for a whole week in the winter. Alone and isolated, he was taken care of by a person who was not constantly with him. The young student, accompanied by a tutor, came to pass a few days in the house. At the sight of the youth, Jaco, surprised, called out, "Momon! Momon!" "It was affecting," they wrote me, "to see so great signs of joy." I have also myself witnessed similar signs of joy at the coming of the student. Jaco's speech at such times is always in harmony with his feelings. In the pleasant season Jaco's cage is put outdoors; and at meal-times, knowing very well what is going on within, he keeps up a steady course of suppliant appeals for attention. His appeals cease at once if I go out with fruit in my hand, and if I go toward him he utters a prattle of joy that sounds like musical laughter. These manifestations indicate that he is happy at seeing that he has been thought of.

I close these anecdotes, as I began them, by repeating that animals communicate their impressions, and the feelings that move them, by various modulations of their inarticulate cries, which are incomprehensible to us unless we have succeeded by attentive observation in connecting them with the acts that follow or precede them. We have also seen that the articulation of a few words learned by parrots aids us greatly in learning the meaning of these different inflections.

The extension of these studies would furnish much of interest; but further observations should be made upon the same animals for a long time continuously, relating especially to their peculiar instincts as manifested by their various cries. We might then, by comparing and relating acts and cries, reach the point of comprehending and perhaps fixing the meaning in many cases where we are now in ignorance. Every one has noticed a few facts, and has interpreted and related them, but much is still wanting for the co-ordination of them in the point of view of the signification of the language and communication of animals among themselves. It has not been made in a general sense.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

According to Prof. G. Brown Goode, the United States is taking a "splendid lead" in the investigation of deep-sea fishes. England, France, Italy, Switzerland, and India have all suspended their investigations, and the United States steamer Albatross represents the whole work of the world in that direction.

RECENT OCEANIC CAUSEWAYS.

By M. E. BLANCHARD, of the Institute of France.

THE object of this paper is the survey of the most remarkable changes that have taken place in the configuration of the land and the seas. My purpose is to show by an aggregation of proofs that the European and American continents were, to a certain extent, united at an epoch of only moderate geological antiquity. When we consider the extent of the Atlantic Ocean between Europe and America, as measured by the usual routes across it, we reject all thought of there ever having been a passage between the two continents in the present geological period. But the assertion of the former existence of such a communication should cause no surprise, if we regard the arctic regions of both shores of the Atlantic. In fact, if we follow a line drawn from the islands north of Scotland through the Faroe Islands to Iceland, from Iceland to Greenland, and from Greenland to Labrador through Davis Strait, which is crowded with islands and islets, we find a chain of lands interrupted only by spaces of sea of small extent, and in some places of no great depth. Subsidences of the ground and erosions have caused the isolation of lands which were united in former ages, when living Nature had assumed a character which has not ceased to exist down to our own days. A similar phenomenon produced the separation of England.

The application of natural history to physical geography and the history of the globe casts a full light upon this matter. The flora and fauna of North America are distinguished from those of Europe by essential traits. This fact contributes in a striking manner to establish the passage of a number of species from Europe to America. The demonstration appears complete when we look at the number and the character of the plants and animals inhabiting both continents. Among these are several anemones,* *Cruciferæ*,† violets, and a number of species of *Stellaria* of the pink family. The astragalus of the Alps thrives in Canada. Among the *Rosaceæ* we find a series of species of northern and Alpine Europe which occur also in North America—*Spiræas*, *Potentillas* and others. Numerous saxifrages, epilobiums, and honeysuckles are common, especially the famous *Linnæa borealis*. Heaths of several kinds, the rhododendron of Lapland, and primroses, have likewise found their way to America. The families of the scrophularias, the labiates, the borages, and the gentians are al-

* *Anemone gratius*, *A. narcissiflora*, and *A. hepatica*.

† *Cardamine bellidiflora*, *Arabis petræa*, and *Draba lueana*.

so represented in the New World by identical species. Among the arborescent plants, alders, willows, junipers, and the common yew exist in the cold or temperate regions of both worlds. While we refrain from dwelling on the grasses and ferns, the dissemination of which to great distances is one of the most common phenomena,* we are able to cite plants which seem hardly adapted to leap over the arms of the sea, such as orchids and lilies of northern Europe, which are also common in North America.

The numerous world of insects furnishes hundreds of examples of species that have passed across from the arctic regions of Europe into America. Of the beetles, insects generally sedentary and possessed of means of locomotion so inferior that they would hardly venture to cross a sea with them, we can mention not less than three or four hundred species as common to both continents. We are particularly struck with the number of carnivorous species (*Carabides*), which, living on the land and hiding under stones, are disseminated very slowly. These species of carnivorous *Coleoptera* may be followed from the north of the European continent to Iceland, the shores of Greenland, Labrador, and Canada.† It would be absurd to suppose that man has been able in his migrations to carry such a multitude of the lower creatures across the ocean. Notwithstanding the daily chances and the continual transportation of all kinds of food-products, the common chafer of Europe has not been introduced at any point in North America.

Lepidopterous insects (butterflies and moths), aided by a favorable wind, are undoubtedly sometimes carried over the sea; and it is not impossible that when they fall upon a land remote from the country of their origin they may live and propagate themselves there. These, however, are exceptional cases, while the *Lepidoptera* of the New World may be counted by the legion. The common vanessas of Europe abound in the northern parts of America,‡ and the argynnes of Lapland and Iceland # and the satyrs of the genus *Chionobas* live also in Labrador. The enumeration could be easily extended.

It is fair to suppose that investigations properly directed would enable us to recognize, in some American forms very close to the European, local varieties of the same species. It may

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* M. O. Franchet, a botanist attached to the Museum of Natural History, has made, at my request, a complete examination of the plants of northern Europe which are diffused to a greater or less extent in North America.

† *Blethera arctica*, *Nebria nivalis*, *Bembidium Grapei*, *Patrobus septentrionis*, *Pterostichus vitreus*, *P. arcticola*, *Amara erratica*, *A. interstitialis*, *A. brunnea*, *Platyrus Bogemanni*, *Miscodera arctica*.

‡ *Vanessa antiopa*, *V. Paolychlorus*, *V. Urtica*, *V. Atalanta*.

\# *Argynnis Freya*, *A. Frigga*.

be further observed, in support of our thesis, that species incapable of great displacements, such as the spiders of arctic countries and Alpine regions, have been observed in Greenland. We can furthermore draw valuable results from the survey of the geographical area of various vertebrates. The common marten, the common sable, and the ermine of the cold countries of Europe, have passed into North America. Specific differences between animals existing in different countries were formerly made too readily, but we are now more careful. A very characteristic type—the beaver—is widely diffused in Europe and in Canada. The differences which the old naturalists defined between the European and American beavers are of the most superficial character, while contemporary zoölogists only distinguish local varieties. Other rodents, like the Norwegian lemming and the variable hare, have followed the same ways as the preceding species, and spread themselves from one continent to the other. Finally, we must not forget the reindeer of Lapland, which also wanders in numerous troops in the coldest regions of North America.

The fresh-water fishes of North America constitute a group very characteristic of a single region of the globe. Yet this fauna is augmented by a few European species. A perch (*Perca flavescens*) should not apparently be separated from the river perch of Europe. The peculiarities in the number and proportions of the spines that garnish the opercle are so variable in individuals that specific distinctions can not be based upon them.* The European river bull-head (*Cottus gobio*), which is spread through all northern Europe, lives in Greenland and North America. The European pike inhabits the fresh waters of North America, along with a distinct species peculiar to the country. Now, it is certain that no river perch or bull-head or pike ever left fresh water. These fishes could therefore have distributed themselves through the two continents only at some time when the lands scattered between the Old and New Worlds were connected.

So abundant are the proofs of a communication by land between Europe and America during a recent age of the earth, that it does not seem too presumptuous to declare it clearly certain.

If we carry ourselves back to the views which prevailed till recently concerning the isolation of America, we shall suffer a kind of surprise in observing most striking resemblances in living

* At my request, M. Léon Vaillant, my colleague in the Museum of Natural History, has examined all the specimens of the American perch (*Perca flavescens*) in the collections of this museum and compared them with the river perch of Europe. The recognized differences are of so little importance as in no way to authorize a specific distinction.

Nature on the two continents. The union between the continents probably existed only in the north, perhaps above the fiftieth degree of latitude. If we follow the most eastern parts of Asia, northern Japan, Siberia, and Kamchatka, which are separated from America by Bering Strait, or if we proceed from the American side through the peninsula of Alaska and the chain of the Aleutian Islands, we shall comprehend at once that only very ordinary geological changes may have been sufficient to bring about the separation of lands which had been long united. Looking toward the extreme north, we find no other separation between the Old and New Worlds than a simple arm of the sea, Bering Strait.

The study of living Nature in the arctic regions of Asia and America is very instructive. Let us begin with examining the vegetation. Some anemones and a ranunculus* of Siberia are now common in North America. Another species of ranunculus † is common to Japan, Kamchatka, Alaska, and northern and eastern America. While we admire the tulip tree ‡ in the parks of Europe, we recollect also that that beautiful exotic is one of the glories of the North American flora. But the tulip tree has recently been discovered in China. Then, there are the violets of Siberia and Japan,# which are mingled also with the vegetation of North America; and a vine (*Vitus Labrusca*), now well known, reputed American, which grows in Japan and a part of eastern Asia. A maple ‖ is common to Japan and North America, as are also *Spiræa betulifolia* (birch-leaved spiræa) and *Potentilla fragiformis* of the rose family, some saxifrages, a crassula (*Penthorum sedoides*), various umbelliferous plants, the maritime alder, and a few orchids and lilies.

The animal world furnishes valuable evidences of our theory. Concerning insects I will cite only the facts most demonstrative of former communications. Some carnivorous beetles, the Carabs,△ insects remarkable for their forms and colors, wingless, and having only their legs as means of locomotion, inhabitants of eastern Siberia, are also found in the cold countries of North America. I first saw collections made in California, after I had already become familiar with the faunas of Europe, Asia, and America. I was then surprised to see in those collections European and Asiatic forms which were believed to be entirely foreign to America. A little French butterfly, also occurring in Siberia, the valley of the Amoor, and Japan, was found on the western coast of America. It appears to be unique in the color of its wings, which are beautifully green on the lower sides. The like-

* *Ranunculus cymbalaria.* † *Trautvetteria palmata.* ‡ *Liriodendron tulipifera.*

\# *Viola rostrata, V. Canadensis.* ‖ *Acer spicatum.*

△ *Carabus Vieilinghosi, C. meander, C. truncaticollis, Cychrus angusticollis.*

ness was most striking. Yet an entomologist, resting on trifling peculiarities hardly the signs of a variety, described it as a new species.* It is impossible to admit this. It was then learned that the genus *Parnassius*, which were believed peculiar to the mountains of Europe and Asia, existed in California. The species were distinct from those of the Old World; according to the conventional expression, they were typical species. Afterward a species of the same genus was observed on the western coast of North America which was regarded as peculiar to Siberia and Mongolia.† *Papilio Hippocrates*, a butterfly of a remarkable type, which was known in Japan, has been found in North America.

Passing to vertebrate animals, I confine myself to the mention of a small number of most characteristic types. Among the rodents we remark the marmot, *Arctomys pruniosus*, or sonslik of Siberia, which lives in Kamchatka, on the Alaskan Peninsula, and on the American continent. Among all the carnivorous animals of the family of the *Mustelidæ*, or weasels, we remark the sable of eastern Asia in Kamchatka, Alaska, and other northern parts of the American continent. A carnivorous animal of another group, the glutton, or wolverine, is found in the same regions.

In this latter part of my paper I have spoken wholly of animals and plants common to Asia and America, as in the former part I spoke only of those common to Europe and North America. But while I omit to make long enumerations of species, I insist on the fact that plants and animals are distributed in considerable numbers over the whole extent of the arctic regions in Europe, Asia, and America, having accomplished the whole circuit of that zone at an epoch when the continuity of the land made possible an indefinite dissemination to the full extent that climatic conditions were favorable.

With the present condition exactly determined, and the former condition recognized, a sure foundation is laid for the science of the future; new changes will be produced in the course of a few centuries in the configurations of the lands and the seas, and then men of science will be able to form theories of value.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

The work of searching for the affinities of great groups is declared by Prof. Coulter to be the crying need of systematic botany. There is danger of magnifying the importance of certain periods or organs in indicating affinities. For the best and most permanent results of systematic botany, it should take into account development at every period and of every organ, and so obtain a mass of cumulative evidence for safe generalization.

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* The *Thecla rubi* of Europe and Asia; the California specimens were described under the name of *T. dumetorum* (Boisd).

† *Parnassius Nomion.*

THE UNIVERSE OF STARS.*

IT is only, curiously enough, within the last decade or two that the science of astronomy has answered to its name. Until the methods of spectrum analysis and of photography were applied to the stars, astronomers were scarcely justified in their title, for they knew little about the stars, and, hardly hoping to know more, almost confined their attention to the solar system. Now, although sidereal astronomy, the science of astronomy *par excellence*, is still in its infancy, we may discern pretty clearly what will be the nature of its achievements. Surpassing the wildest dreams of the older astronomers in range and penetration, modern astronomy yet brings the whole cosmos within the grasp of human intelligence. Not only are the stars in process of being numbered, their motions, proper and relative, in course of measurement, their physical constitution subjected to analysis, and their distances brought within computation; but the entire sidereal system is recognized as limited in extent, and the form and magnitude of the vast group in space will at no distant date become susceptible of approximate delineation and calculation.

Of the methods referred to, photography has had, perhaps, the largest share in the recent advancement of sidereal science. The chemistry of the stars, it is true, is founded wholly on spectrum analysis, that profound and searching means of testing the composition of bodies by the action of elementary substances, under proper conditions, upon the infinitesimal undulations which give rise to the phenomena of light; but without the aid of photography, the mapping of star-spectra must have remained a slow and inaccurate process. The camera, on the other hand, has revealed almost all that is known concerning the number, distances, masses, and motions of the stars; the lens has no "personal equation," and never gets tired; sensitized gelatin responds with infinite celerity to the undulations which make no impression whatever upon the eye; and star-pictures of the heavens are not only permanent records, but, with the proper instruments and skill, can be so readily taken that before very long it is probable that some seven hundred thousand out of the whole sixty millions of stars will be accurately charted and indexed.

For such is the least number of the heavenly host—which a French astronomer somewhat extravagantly estimates to contain nearly seventy thousand millions of suns; for each star we see is a sun shining with its own light, and governing probably, like our own, the motions of a system of planets. Nor is the light

* The System of the Stars. By Agnes M. Clerke. London: Longmans. 1890.

they send us inconsiderable, for the total effulgence of the stars down to the $9\frac{1}{2}$ light-magnitude is equal to one eightieth part of the effulgence of a full moon in a clear sky. What light we get from the stars of lower magnitude it is difficult to say, but it is clear that the stellar world is not boundless, for were it so the light from the infinite hosts of more and more remote suns would, as Miss Clerke says, fill the sky with an indefinitely intense radiance. It must, however, be remembered that it is not known whether the undulations which cause light are capable of infinite propagation. Nor, it may be added, can one be certain that the mass of ether in which our cosmos swims is the only one in space; or, if space and ether be taken as convertible terms, that it is the only mass differentiated—coarsened, so to speak, into a condition fit for the evolution of matter and energy, and of the suns and solar systems thus brought into being. The stars are arranged according to their light-magnitudes, to each magnitude the numerical value $2\frac{1}{2}$ being assigned, for mathematical reasons that can not be here explained. Altair and Aldebaran are, strictly speaking, the only stars of the first magnitude, and the light of either of them would equal that of one hundred stars of the sixth and one million stars of the sixteenth magnitude. Sirius, however, is nine times as bright as Aldebaran, and its magnitude accordingly is expressed by the value $-1{\cdot}4$. Among the suns visible to us, it comes next to our own sun, whose magnitude is reckoned at $-25{\cdot}4$; in other words, the sun is (to our earth) between three and four million times as luminous as the Dog-star. The most accurate photometric measures of the stars are now made by the aid of photography, and the astronomers of a thousand years hence will have before them exact light-histories of nearly all the millions of stars of which the delicate and tireless gelatin films can seize and retain the faintest light-impressions. To what undreamed-of knowledge of our cosmos this wealth of accurate records will lead!

One of the most important results of stellar photometry is the aid it affords toward determining the distances of the stars. The mean distance of stars of the same magnitude is approximately the same; and if, therefore, the distances of some of the nearer stars are obtained, the approximate remoteness of any given category is easily calculated. But to find independently the distance of any individual star, its parallax must be known—the angle, that is, between two lines drawn from the ends of a base-line of known length to the star in question. Now, if the mean distance between earth and sun be taken as such base-line, 93,000,000 miles in length, to include an angle of one second (one 324,000th of a right angle), the line must be drawn to an object $206{,}265 \times 93{,}000{,}000$ miles distant. Well, *no star is so near as this.* The nearest star,

α Centauri, has a parallax of three fourths of a second. To bring within easier comprehension the enormous distance this parallax involves, let the rapidity of light be considered. Light travels at the rate of over one hundred and eighty thousand miles a second, and a year of such travel may be taken as a unit for star-distances. Thus, the distance of α Centauri would be measured by nearly $4\frac{1}{2}$ "light-years." The Polar Star is forty light-years, Sirius one hundred and twenty-one light-years, distant from our globe; while stars of the sixteenth magnitude may be so remote that it would take a wave of light thirty-six thousand years to reach the solar system. The parallax of Sirius is only about one thirty-third of a second—a striking example of the dependence of the most prodigious measurements of astronomy upon the minutest readings of apparatus, necessitating the utmost perfection of workmanship, as well as consummate skill and knowledge on the part of the observer.

Over eight thousand nebulæ have now been subjected to examination. The great nebulæ in Andromeda and Orion are, of course, familiar to every one. The telescopic nebulæ are of all sizes and shapes, and scattered over the whole heavens. Many stars have nebulous wisps and whirls, tails and helices, attached to them. The nature of nebulæ is still more or less of a mystery. But it is certain that they are initial, or at least early, phases of the life-history of stars. That life-history may be shortly stated in Miss Clerke's own words:

> By the ceaseless advance of condensation nebulæ are transformed first into gaseous stars (showing bright lines in the spectrum, and therefore shrouded in glowing atmospheres, chiefly of hydrogen and helium), then into stars with banded spectra (showing outer atmospheric strata below incandescence over inner strata at glowing heat), from which (by further condensation and increase of inner heat below irregular outer clouds of metallic vapor) solar stars, and from these again Sirian stars, gradually emerge. Here the ascent ends; the maximum of temperature is reached, and a descent begins, the initial stage of which is marked by a second group of objects like our sun and Capella, distinguished from the first by the circumstance that they are losing instead of gaining heat; while, lower still, the condition immediately antecedent to solidification and obscurity (dark stars) is represented by Father Secchi's "carbon stars."

The nebula in Orion is of a very irregular shape; imbedded in it lies the stellar group θ^1 of the constellation, and some other stars, all of which together seem to form an enormous system whose dimensions can scarcely even be guessed at. Examined by the spectroscope, the nebula is found to consist of glowing gas, which the spectrum indicates to be a mixture of hydrogen and nitrogen. The Andromeda nebula, on the other hand, presents a well-defined oval, and gives a continuous spectrum in which no bright lines have been certainly distinguished. It may, therefore,

be not a nebula at all, but a cluster of stars so enormously remote as to be unanalyzable by the most powerful of modern telescopes. In relation to nebulæ, a word may be said on Mr. Lockyer's ingenious "meteoric theory," submitted to the scientific world in 1887. Nebulæ, he asserts, "are composed of spare meteorites, the collisions of which bring about a rise of temperature sufficient to render luminous one of their chief constituents, magnesium." But the spectroscopic coincidences upon which this theory is based are by no means verified, nor has any comprehensible theory of the origin of these meteorites—very complex bodies, according to the samples that have reached our earth—been offered. If, following the indications of recent chemical and physical research, we consider the elements as molecular differentiations of the ether, the nebulæ may present stages in this differentiation in which the molecular states of some of the elements are not identical with those with which we are familiar in the laboratory, in which, indeed, certain of the elements may not yet have been evolved.—*The Spectator*.

SKETCH OF WILLIAM EDWARD WEBER.

WITH the death of Weber, June 23, 1891, passed away, as M. Mascart, of the Central Meteorological Bureau of France, has well said, the last representative of that generation of men of science that cast so much luster on the first half of this century. He was also the last survivor of that group of experimenters in Europe and America whose labors gave the world the electric telegraph; the one among them who first demonstrated that communication by electricity was possible and practicable.

WILLIAM EDWARD WEBER was born in Wittenberg, Prussia, October 24, 1804. He was the second of three sons of the learned theologian, Michael Weber, Professor of Theology at Wittenberg. The other two sons became doctors, both contributed to science, and both co-operated with the subject of this sketch in some important investigation. Weber studied at the Frankean School and the University of Halle, received his doctor's degree in 1826, became privat-docent at Halle in the next year, and Professor-Extraordinary of Physics there in 1828. In 1831 he was appointed to succeed John Tobias Mayer as Professor of Physics in the University of Göttingen. He remained there till 1837, when a political event caused his retirement. On the death of King William IV of England and Hanover, the kingdom of Hanover was separated from England by the operation of the Salic law, and fell to Ernest Augustus, Duke of Cumberland, uncle of King

William. Ernest was a believer in the supreme right of kings, and set aside the Constitution which William had granted in 1833. At the same time he called on the public officers of the country, including the professors in the university, to take an oath of allegiance to him and of obedience to his new rule. Weber with six of his fellow-professors — Jacob and William Grimm, Dahlmann, Albrecht, Gervinus, and Ewald — protested against the arbitrary act, and refused to conform to it. "The entire effect of our work," they said, "depends not more surely on the scientific value of our teaching than on our personal freedom from reproach. So soon as we appear before the students as men who trifle with their oaths, our efficiency is at an end. And what would the oath of our fidelity and homage be worth to his Majesty the King, if it came from men who had just frivolously set aside another sworn obligation?" For this refusal the seven professors —"the Göttingen seven" they are called—were removed from their chairs, and three of them (Gervinus, Dahlmann, and Jacob Grimm) were expelled from the country. After this event Weber lived in retirement as a private teacher in Göttingen till 1843, when he was called to be Professor of Physics in the University of Leipsic. According to a German biographer, he never felt quite at home in Leipsic, and gladly accepted an invitation in 1849 to his old place in the Georgia Augusta at Göttingen, where he spent the rest of his life, "with rare fullness of enjoyment pursuing his learned work, never anxious about the show of success, but finding complete satisfaction in the peculiar joys of scientific achievement, furnishing thus a shining example in opposition to the restlessness of our age."

With his eldest brother, Ernst Heinrich, who, a physician, with particular devotion to anatomy and physiology, had become interested in the solution of certain difficult questions in physics, Weber engaged in the investigation of some of the phenomena of wave-motion. The result was the publication, in 1825, when Weber was twenty-one years old, of the book *Die Wellenlehre auf Experimente gegrundet* (The Doctrine of Waves, based on Experiments), a volume of five hundred and seventy-four pages, with eighteen copper plates, mostly engraved by the authors. One of the striking results of the investigations was the discovery that, when a regular series of waves follow each other along the surface of water, the particles at the surface describe vertical circles, the plane of which is parallel to the direction of propagation of the waves, and those lower down ellipses, of which the vertical axis becomes smaller and smaller with increasing depth. The work was, according to the declaration of the authors, the result of such constant and intimate communication between them with regard to all the parts that it was impossible to assign

to either of them the separate authorship of any distinct portions.

A few years afterward, at Göttingen, Weber was engaged in another investigation with his brother Eduard Friedrich, who was also a doctor interested in physical studies, of the mechanism of walking, the results of which were published in the book *Mechanik der menschlichen Gehwerkzeuge*. The salient feature of this work, in which many novel facts were brought out, was the enunciation of the fact that the pressure of the air is a factor in holding the bones in place in the joints.

For several years Weber was occupied mainly with questions of acoustics, on which, as well as upon electricity, heat, and light, he published many important papers.

His title to be regarded as one of the masters in science rests chiefly on his researches in electricity and magnetism. His position as professor at Göttingen brought him into close association with Gauss, who was as devoted to mathematics as Weber was to physics. The two assisted and complemented one another: Weber needed calculations to bring out the bearings of his experimental results, and Gauss was ready to take up any serious problem that needed solution.

Gauss, according to M. Mascart, besides his work in analysis and celestial mechanics, had given his attention to the mathematical theory of electricity and magnetism, in which he found many analogies with that of universal attraction. He had published a memoir describing an experimental method superior to that of Coulomb for verifying the law of magnetic actions, and a general theory of the magnetism of the globe and the relations between the results obtained at different stations. He established a magnetic observatory, where the methods of calculation he had devised were applied; and with Weber's collaboration an extensive association was formed, including the directors of the principal observatories, chiefly in Germany, for making a systematic study, under a common plan, of the continual variations of terrestrial magnetism. The results of this great enterprise were published by Weber from year to year, and collected in a magnetic atlas of the globe. In memory of this initiative, the Meridian of Göttingen is still preserved as the point of departure in a large number of general studies on the distribution of terrestrial magnetism. This common labor led to the installation, by the two co-workers, in 1834, of the first electric telegraph, by which an important date is marked in the history of telegraphy.

The idea of telegraphing by means of electricity was not entirely novel then. Samuel Thomas von Sömmering, of Munich, had experimented upon it with some success in 1809. Ampère, in 1820, and Fechner, in 1829, had proposed the utilization of the magnetic

needle for making signals. But none of these efforts had advanced beyond the experimental stage, and they were only of historical value. They illustrate the general principle that a great discovery hardly ever springs from the thought of a single man. But the fact that there were preceding tentatives does not diminish the fame of the man who gathers up and combines the previous results and completes what they had left unfinished. Weber was the first who established a permanent workable telegraph line, and thereby demonstrated the practical value of the electric telegraph. Weber's house in the city was connected with the astronomical and magnetic observatories by a line between three and four kilometres (over two miles) in length. The signals were made by the deviations of the needle of a galvanometer to the right and left and were interpreted according to a conventional alphabet. The use of interrupted or reversed currents did not permit the transmission of more than one or two words a minute, but the speed was increased to seven or eight words by the use of induced currents.

The following first notice of this telegraphic connection was published in one of the numbers of the *Göttingischen gelehrten Anzeigen* (or Göttingen Scientific Notes) for 1834: "We can not omit to mention an important and, in its way, unique feature in close connection with the arrangements we have described [of the Physical Observatory], which we owe to our Prof. Weber. He last year stretched a double connecting wire from the cabinet of physics over the houses of the city to the observatory; in this a grand galvanic chain is established, in which the current is carried through about nine thousand feet of wire. The wire of the chain is chiefly copper wire, known in the trade as No. 3. The certainty and exactness with which one can control by means of the commutator the direction of the current and the movement of the needle depending upon it were demonstrated last year by successful application to telegraphic signalizing of whole words and short phrases. There is no doubt that it will be possible to establish immediate telegraphic communication between two stations at considerable distances from one another."

Weber's general magnetic and electrical researches, by which his place in the history of science is most conspicuously marked, are described in the *Resultate aus den Beobachtungen des magnetischen Vereins* (Results from the Observations of the Magnetic Union), published by Gauss and Weber from 1837 to 1843, and in Weber's *Elektrodynamische Maasbestimmungen* (Electrodynamic Measurements), published from 1846 to 1874. Of these, M. Mascart says that "the thought of measures in mechanical unities was naturally applicable to the reactions which take place between conductors traversed by electric currents and between cur-

rents, the laws of which had been established by Ampère for the permanent effects, and by Faraday for the transient effects produced by currents of induction. Weber found in them a new road and a personal glory. The series of memoirs in the *Elektrodynamische Maasbestimmungen* constitute an imperishable scientific monument, in which the extent of the descriptions may sometimes appear long to the reader eager to get on, but the attentive study of which is ever fruitful. It is impossible to give an adequate estimate of this work in a short analysis; we shall only point out a few of its salient traits. The invention of electrodynamometry, which depends on the reciprocal action of currents, permitted Weber to subject Ampère's law to a vigorous testing by a method that differed from that of Gauss only by the substitution of coils for magnets. The close study of the deviations produced in galvanometric apparatus by permanent or temporary currents furnished him with a means of devising precise methods of observation, of measuring quantities of electricity corresponding to the discharge by the impulse impressed by them on the magnetic needle, and of estimating the approximate duration of the discharges by a combination of the galvanometer and the electrodynamometer.

In the course of his experimental researches, Weber made known an important formula which includes in a single expression Coulomb's laws of electrostatics, Ampère's laws on the reciprocal action of currents, and the phenomena of induction described by Faraday. Gauss seems not to have been a stranger to the selection of this formula, and the theoretical conceptions which are its basis may give occasion to discussion; but Weber has the merit of having shown all its consequences by establishing for the first time a close connection between phenomena that appear independent. Weber's labors are particularly distinguished by the introduction of the absolute measures which have contributed for several years to the rapid progress of electricity as a subject of pure science and in its industrial applications. To him, in fact, we owe the suppression of a vague terminology in which currents were estimated by the kind of piles and number of couples, the length and size of circuits, or the deviation produced in a dynamometer of which only the number of turns of wire was indicated. The inestimable services that have been derived from the employment of absolute measures justify the attribution of the name of *weber* to the unity of the current as defined by its electromagnetic action, for which the mechanical unities of Gauss —the millimetre, the milligramme, and the second of mean time —are adopted.

Weber's biographer in Nature gives Sir William Thomson the credit of having been one of the first men of science to recog-

nize the fundamental character and far-reaching importance of Weber's work; and, owing mainly to his clear-sighted advocacy of the absolute system of measurement, this system was from the first adopted as the basis for the operations of the British Association Committee on Electrical Standards, appointed originally in 1862. "This system has now become so familiar to electricians, and is taken so much as a matter of course, that it requires some mental effort to recall the state of science when it did not exist, and to appreciate the intellectual greatness of the man to whom it is due. If we consider method and point of view, rather than acquired results, it is not too much to say that the idea of absolute measurements, underlying as it does the conception of the conservation of energy, constitutes the most characteristic difference between modern physics and the physics of the early part of our century. And to no one man is so large a share in this great step due as to Wilhelm Eduard Weber."

Weber, in conjunction with Kohlrausch, determined the relations between electrical and magnetic measurements expressed in the same unities, concerning which there seems to have been some confusion. He determined the chemical actions by electrolysis which correspond with the passage of a unity of current in a second, and by this furnished a practical means of reconstituting that unity in experiments. He pointed out and put in practice some of the most precise methods for determining the numerical value, as related to the fundamental unities, of the electrical resistance of a conductor. His name is also associated with numerous labors for fixing the value of the practical unity of resistance, or the ohm, in terms of the mercurial column.

So retired was Weber's life in his later days that, though his fame had not diminished, the world had almost forgotten that he was still in it; and it is said that when, at the meeting of the German naturalists in Berlin a few years ago, the name of Weber was read in the list of those who had taken part in the first meeting held there in 1828, surprise was expressed at recognizing in their octogenarian friend one who had sat there with Berzelius and Ohm and Heim.

Weber was a corresponding member of the Institute of France, and had been a foreign member of the Royal Society since 1850.

EDITOR'S TABLE.

UNIVERSITY EXTENSION AND THE STATE.

THE writer of the able article on university extension which appeared in the November Monthly, does well to come forward in the present number and further develop his views as to the best means of securing the success of the university-extension movement. He does not agree with the opinion we expressed in the "Table" for November, that the movement in question should be carried on in entire independence of Government assistance. He thinks, on the contrary, that, unless the national Government comes to its aid with a grant of money, the work which is proposed "can not be thoroughly or systematically done as regards the country at large"; and he takes occasion to indicate what he considers to be the true theory of the state. The arguments of our valued contributor, we must say, have not convinced us; and, considering the importance of the subject, we feel sure that we shall be excused if we say a few more words upon it from our own point of view.

The university-extension scheme, we must assume, has been called into existence to meet a public demand. Prof. Henderson says: "The work promises to be much too large for private enterprise." We interpret this to mean that there is a great and growing interest in the extension movement—that the public are, to an encouraging extent, alive to its importance; but, if such is the case, instead of saying that the work promises to be "much too large for private enterprise," we should say that private enterprise bids fair to cope most successfully with the work. If public interest has not been awakened in an encouraging degree, we fail to see the force or propriety of the word "promises" as used by Prof. Henderson; if it has been so awakened, we say, let us wait and see what public interest and private enterprise will do before we dream of asking for a share of the taxes to support the movement. We are strongly of opinion that people should pay for the bread of intellectual life. If they pay for it they will value it, and not scatter it by the roadside, as beggars do bread given in alms. There is invariably far more intellectual interest in a class all the members of which pay the full amount of their own fees; the attendance is more regular, the attention is more keen. Every one can verify this from his own experience. A traveling teacher or professor visits a town or village and offers to teach a class of so many some particular subject at so much a head. If the class is formed, every one, as a rule, does his or her best to get the most out of it. Nobody goes there to trifle, nobody cares to miss a lesson. Now, what university extension has got to do is to offer the people what they want in the way of instruction and invite them to pay for it. If it offers the people what they do not want they will not take it; and here we see one of the mischiefs of Government interference. Why have the old universities of the world been so slow to move out of their ancient ruts, so slow to adapt their teaching to the new requirements of a new age? Simply because they have had large endowments and have been to that extent independent of public opinion. If a certain subject declined in interest, the university could go on teaching it to all but empty benches. The endowment was there, the chair was provided for, and why should any change be made? Precisely so with our university-extension movement: backed by Government money it would inevitably be less swayed by considerations of public utility, and more by the estab-

lished conventions, not to say fictions, of the teaching profession, than if it were wholly dependent on the free response of the public.

Another objection that we make is that the idea of using the proceeds of taxation in aid of the movement gives it too indeterminate a character. Prof. Henderson's own language shows this. "Once established," he says, "these district central offices of the Department of Education might, with perfect propriety, go a step further and provide, under suitable conditions, for part of the expense of an extension course where the proceeds from the sale of lecture-tickets were not sufficient. With the people themselves directly creating each center, electing their own subject, choosing their own lecturer, and paying for *all or part* of the local expense, I really do not see how the movement could become commonplace or mercenary in its character by being systematized under national auspices." The words we have italicized are significantly vague. Will it be pretended, besides, that the agency disposing of the Government grant would not have a great deal to say as to the mode of its application, and would not, in many cases, override local choice as to subjects and lecturers? If of two localities, both aspiring to the grant, one fell in with all the views of the district center, while another stood out for some plan of studies of its own, can any one doubt that the tractable locality would have much the better chance of getting it? Another point is that as soon as it became a matter of distributing Government money, all kinds of local jealousies would arise; and politicians would appear upon the scene to demand that their special localities should not be neglected. We incline to think that, if Prof. Henderson could only be brought into contact with two or three average Congressmen wrangling over what they would regard as a division of the spoils, his confidence in the beneficent influence of a subsidy would be somewhat shaken.

We do not know how our contributor arrives at the induction he puts forward with so much confidence that "the sum of American public infamy is neither absolutely nor relatively so great as the sum of American private infamy"; but we must be allowed to question the value of the formula. We are told that the Government is corrupt only because the people are corrupt. There is doubtless some general truth in the statement; but it ought not to be forgotten that one way in which the corruption of the people shows itself is in taking money in taxes which they could not get in any other way, and to which they have no right. Appropriation-hunting has long since been reduced to a science, and no one who has carefully watched the politics of this or any other democratic country can doubt that every additional appropriation made by the Legislature becomes to some extent an additional corruption fund. Granting even that the appropriation once voted is honestly expended as a matter of account, the very granting of it in many cases was an act of theft viewed from one side and an act of bribery viewed from another. The locality or interest that clamors till it gets what it wants, without regard to the general welfare, virtually steals; and the combination of politicians that procures the appropriation aids in the theft for purposes of bribery. To say, therefore, that such money does not stick to the hands of the officials who expend it is not saying much. They doubtless, as Prof. Henderson hints, are more or less compelled to be honest—the dishonesty was perpetrated in the passing of the vote by which the money was obtained in the first place. When Prof. Henderson tells us that our officials are not so bad, and that we should not be afraid of the Government which is our own creature, he misses the mark. We are not afraid of the officials, whose functions are

largely analogous to those of employés in private firms or corporations; what we are afraid of is the really irresponsible action of our legislators who are sent to Congress almost solely as representatives of local interests, wholly unembarrassed by local consciences. Our real *Government* is not the executive—it is the Legislature; and if Prof. Henderson will take the responsibility of stating that the private business of the country is carried on on less honest principles than the business of legislation, we think he will surprise most well-informed readers.

We must demur altogether to Prof. Henderson's identification of liberty with *power* or *faculty*. If a man can not swim, we do not say he is not at liberty to swim. If, on the other hand, a boy *can* swim, but is not allowed to by his parents, we say he is not at liberty to swim. The business of Government, according to Herbert Spencer, to whom Prof. Henderson refers, is to protect individuals in the exercise of already acquired faculties and powers, not to take measures for enlarging their faculties and powers: that, he holds, they should look after for themselves. Liberty means nothing else than freedom from external restraint; and to assume, as Prof. Henderson seems to, that a man free from external restraint is not truly free unless he has also a wide range of action is about as logical as to say that a man can not be truly sane unless he has a very wide range of knowledge. Yet it is on the strength of this apparent confusion of thought that Prof. Henderson asks us, in the name of liberty, to intrust the Government with a great diversity of functions for the purpose of "making desirable individual action possible"! We sincerely trust that university-extension lecturers will not be found teaching this doctrine, and arguing that a man's freedom is increased when he gets cheaper postage, or any other added facilities for action. In the sense in which Prof. Henderson is using the word "liberty," it would surely be the duty of the Government to see that every man was well supplied with pocket-money, since nothing so circumscribes action as poverty.

Finally, we fail to see much force in the paragraph in which our contributor sums up his case: "A governmental action which compels is mischievous; an activity which says, 'Thou mayst; lo! here are the means,' is helpful." Surely it is obvious that before the Government can say "Thou mayst; lo! here are the means," it must have taken those means from somebody else. The one great form of compulsion which governments nowadays have it in their power to exercise is this one of taxation. The business of Government is not to say "Thou mayst" to any one, but to say "Thou must *not*" to every one who shows a disposition to encroach on the liberties of his neighbor. "Thou mayst" in the mouth of the Government is almost, if not quite, an impertinence. "Thou must not," if uttered in the right quarter, is the watchword of individual liberty.

LITERARY NOTICES.

The Cause of an Ice Age. By Sir Robert Ball, LL. D., F. R. S., Royal Astronomer of Ireland, author of Starland. Modern Science Series, Vol. I. New York: D. Appleton & Company. 1891. 16mo. Pp. xii + 180. Price, $1.

As a mathematician, Dr. Ball has a high reputation, and he has at the same time rare ability in popularizing his themes. Even those who have little mathematical knowledge will find no difficulty in understanding the main points of this volume, while the abstruse formulas upon which his theory depends are relegated to a short appendix, where they can be examined at leisure by those who are competent to carry on extended mathematical calculations.

In his opinion, the discovery which Dr. Ball has made lends strong support to the theory of Adhémar and Croll, namely, that the great Ice age was produced by the precession of the equinoxes during a period of

an extreme ellipticity of the earth's orbit. The sun is now about three million miles nearer us in the winter than in summer, and the winter (that is, the time from the autumnal to the vernal equinox) is seven days shorter than the summer. In about eleven thousand years from now the condition of things will be reversed, and the northern hemisphere will have a summer seven days shorter than the winter, occurring while the earth is three million miles nearer its source of heat. About two hundred and fifty thousand years ago the eccentricity of the earth's orbit was so great that the difference in these seasons was thirty-three days, and the difference between the distance of the earth from the sun at perihelion and that at aphelion was seven or eight million miles.

These facts served as the basis for Mr. Croll's theory, who assumed, on the strength of Herschel's authority, that the absolute amount of heat received by the earth during the season which occurred in perihelion was the same as that received during aphelion. He reasoned, therefore, that when the winters occurred in aphelion both their increased length and the greater distance from the sun would favor the radiation of heat to such an extent that a glacial period would be produced, especially in those periods when the eccentricity of the earth's orbit was greatest. Dr. Ball comes to the aid of Mr. Croll by showing that the distribution of heat between summer and winter is not in equal quantities, as supposed by Mr. Croll, but that sixty-three per cent of the annual heat received by a hemisphere of the earth falls upon it during the summer—that is, from the vernal to the autumnal equinox—and only thirty-seven per cent during the winter. If, therefore, there was any truth in Croll's original theory, Dr. Ball's discovery will greatly increase the efficiency of the cause.

But the accumulating objections urged by geologists against the theory of Mr. Croll must still apply with all their force. For after Dr. Ball's amendment there is even greater demand than before for geological evidence of a long succession of glacial periods, especially during the later geological eras. But it is the universal opinion of geologists that the Tertiary period was throughout one of great mildness of climate, even up to the vicinity of the north pole; yet the Tertiary age doubtless stretched over more than one period of extreme eccentricity of the earth's orbit. Furthermore, the point of glacial radiation in North America is not the north pole, but the region south of Hudson Bay. So clearly is this the case, that President Chamberlin (who has charge of the glacial department of the United States Geological Survey) has adopted the theory that the cause of the glacial phenomena of North America was an actual change of the position of the pole; while others, who can not give their adherence to so improbable a cause, are laying renewed emphasis upon the changes of level in the earth's surface which occurred toward the close of the Tertiary period.

While, however, we are not convinced of the adequacy of Croll's hypothesis, even as amended by Dr. Ball, we can speak most highly of Dr. Ball's work in bringing clearly before our minds a possible astronomical cause for the Glacial period with which all students of this attractive subject must reckon. The defect in the theory lies not in the mathematical calculations, but in our real lack of knowledge concerning the causes which distribute the heat over the surface of the earth. Meteorology is the science to which we look with most expectancy for further light upon the cause of the Glacial period. The astronomical causes suggested by Dr. Ball's discussion may be so readily masked by slight changes in the direction of oceanic and atmospheric currents produced by relatively slight changes of land level as to be almost entirely ruled out of account.

Systematic Mineralogy, based on a Natural Classification. By Thomas Sterry Hunt, M. A., LL. D. New York: Scientific Publishing Company. Pp. xvii + 391, octavo. Price, $5.

This volume aspires to fill a unique place in the literature of mineralogy. As the author notes in his preface, there is no lack of treatises on the science, both determinative and descriptive. Still, to a naturalist familiar with the methods of nomenclature in the animal and vegetable kingdoms, the names of mineral species are barbarous, trivial, and unmeaning. This state of affairs

springs from the absence of a natural and rational system of classification, such as long since was introduced in the organic worlds. Not that attempts at this needed classification have been wanting. Two rival schools for many years have contended for methods diametrically opposed. The so-called natural-history or mineralogical method was advocated by Werner, Mohs, Jameson, Shepard, and Breithaupt; the chemical method, as formulated by Berzelius and developed by Rammelsberg, has been the basis of the text-books of Phillips, Dana, and Naumann. The possibility of reconciling these apparently antagonistic systems has been the aim of our author throughout his long career of study. Labors in this direction, which from time to time have been brought to the attention of the scientific world, are in the present volume connected and completed, forming what he terms a natural system of classification. He approaches his main task by a presentation of those elementary principles of chemistry and physics which underlie alike the two rival methods hitherto in the field. He discusses the nature of chemical combination, of which he holds that solution is a phase; the periodic law; and the important problem of ascertaining the relative degree of chemical condensation, upon which depends the varying hardness and insolubility of species. Between the physical characteristics and the chemical constitution of a mineral subsist necessary relations; on these rest the new classification, in which the seeming contradictions of the two rival schools are brought to accord. In place of the old trivial names we are given a classic Latin nomenclature for classes, orders, genera, and species — that for species being binomial. This system realizes, in a simplified form, that projected by Breithaupt and left unfinished by him. An examination of his nomenclature, as well as of those proposed by Mohs and by Dana, is followed by a synopsis of native species, with both their scientific and trivial names. This is succeeded by a critical discussion of the more important genera and species. In his two concluding chapters Dr. Hunt presents original and striking views of the genesis of carbonaceous minerals—graphite, diamond, petroleum, and coal; and, further, upon the mineral history of natural waters. In his preface our author announces his intention of preparing a descriptive mineralogy based upon this new classification.

Schliemann's Excavations: An Archæological and Historical Study. By Dr. C. Schuchardt. Translated from the German by Eugénie Sellers. New York: Macmillan & Co. Pp. 363, with Plates. Price, $4.

The author of this book is Director of the Kestner Museum in Hanover. His purpose in writing it has been to present the results of Schliemann's Excavations in a concise form, which should make them more accessible to the general public; and the work appears to have been undertaken with the sanction of the discoverer. He has also sought, by careful discussion and comparisons, to find what are the ascertained results, and to present them free from the conjectures and enthusiastic speculations with which Schliemann's first reports, from the nature of the conditions under which they were written, are necessarily encumbered. The author was engaged in Grecian archæological excavation at Pergamos when he was intrusted with the preparation of the work. He improved the opportunity he then had of making personal observations on the spot, and of informing himself by intercourse with the persons concerned. The undertaking was a difficult one, for the questions which Dr. Schliemann's activity had called up are still undecided, and additions to our knowledge on the subject are constantly furnished by further excavations. But it was pleasant, for these objective studies in Greek antiquity have a charm that is surpassed in no other pursuit. In the account of Troy the history is given of the controversy of the two rival sites, the topography is compared with the references in the Iliad, and the reasons are given—all in seventy-five pages—for believing conclusively that Homer's Troy was real and Schliemann's identification of it is correct. Tiryns is described, in forty pages, as affording the most ancient illustrations of the civilization of which Mycenæ has furnished so numerous and so splendid examples. The largest space is given to Mycenæ, with its remarkable tomb-structures and treasure-chambers, and its truly astounding richness

in work of the goldsmith's art. A brief chapter on minor excavations includes accounts of the researches at Orchomenos and Ithaca. In a Historical Survey of the Heroic Age of Greece, the relations of Mycenæan civilization to that of Greece and Caria are discussed. Among the general conclusions to be drawn from Dr. Schliemann's Excavations are that they invariably confirm the former power and splendor of every city which is mentioned by Homer as conspicuous for its wealth or sovereignty; that the strongly fortified citadels, which do not appear after this (the Mycenæan period) either in Greece or Asia Minor, correspond exactly with those described by Homer; and that the wealth of metals in this "period of youthful display" is distinctly reflected in Homer. "But for the golden treasures of the shaft-graves, Homer's tales of chased goblets like the cup of Nestor, of bossed shoulder-belts, and the golden dogs that kept watch before Alkinoos's door, would still be treated as bold flights of fancy, as was, in fact, the case before the excavations." But the most striking and important correspondence between the Mycenæan discoveries and Homer is that shown in the inlaid work on certain dagger-blades found at Mycenæ. "Nowhere else in Greece has work of this sort, complete pictures in inlaid metals, been discovered. Yet Homer had a very clear conception of this kind of workmanship, for he describes in detail how, on Achilles's shield, vineyards were represented with purple grapes on golden stems, surrounded by a hedge of tin, and later on speaks of youths wearing golden swords hung from silver baldrics. It is enough to enumerate these leading points of agreement. They are sufficient proof that for certain parts of his descriptions Homer can have had no other models before him but those of Mycenæan art and civilization." The controversy still rages on the question whether there was a single personal Homer, author of the Iliad and the Odyssey, or whether the two books are collections of different sagas, sung by different minstrels, and composed in different ages. The author assumes the latter view, and speaks throughout the book as if it was a settled fact. He is sustained in this by Mr. Walter Leaf, an eminent English Homeric scholar, who furnishes a valuable critical introduction, in which the bearing of Dr. Schliemann's discoveries on this and other questions of Homeric interpretation are referred to rather than discussed, but who differs from the author on one or two points. In the appendices are given a report on the excavations at Troy in 1890, with the welcome announcement that Mrs. Schliemann will continue the work of her husband there; and an illustrated description of the two beautiful golden cups discovered in the tumulus at Vapheio—one of the most remarkable and interesting "finds" recorded as yet in the whole history of Greek archæological research.

The Scientific American Cyclopædia of Receipts, Notes, and Queries. Edited by Albert A. Hopkins. New York: Munn & Co. Pp. 675. Price, $5.

This compilation well illustrates the use of the accumulation of small things. For nearly fifty years the Scientific American has been publishing original contributions of facts, experiences, experiments, and practical observations in nearly every branch of the useful arts. The items have been printed in all departments of the journal, but especially in the columns of "Notes, Queries, and Correspondence," where their modest appearance furnished the careless reader no clew to their real worth, but whence the student seldom turned without having gained some prized acquisition to his knowledge. A considerable proportion of them embodied the fruits of special knowledge, which were made public nowhere else. In the files of the periodical they were as good as lost. Mr. Hopkins has made the vast compendium they afford the basis of his work. He has collected these, carefully digested and condensed them; has added to them the results of laborious researches among the difficult mysteries of Trade Secrets, and has incorporated with them, for the rounding off of his fabric, information from other cyclopædias of similar character. The arrangement of articles is alphabetical, according to their titles, with no other classification, the titles being given in full-faced type, with cross-references when they are needed. Illustrations are given, but not frequently. A few cautions are sounded in the preface to those

who are to use the receipts, concerning the need of care to obtain the right materials and pure materials, to follow the directions precisely, and observe all precautions in detail. Tables of weights and measures and chemical synonyms are given in the appendix.

In the *Land of the Lingering Snow* (Houghton, Mifflin & Co., $1.25) a winter outdoor book is given us by Mr. *Frank Bolles*, of Cambridge, Mass. In twenty-six essays the "Stroller in New England," as the author styles himself, chronicles his weekly visit to points of interest within not too hard reach of his home, from January to June. They were made, in fact, twice a week, for he took both Saturday and Sunday for his excursions. In them he enjoyed the weather, whatever it might be, the exultation of facing the fiercest storms if they came, the scenery, and the birds. No stress of weather seems to have deterred him from taking his short railroad trip and long walks, or to have overcome the enterprise of the birds, which he never failed to find in numbers. On the first Sunday of the year, in the deep snow, he finds traces of a crow, fifteen quail, and a robin; the next week, when everything is covered with ice, twenty chickadees, crows, robins, and a hawk; on the third walk, in a tempest, eighty-five birds, representing nine species. They seem to have been the objects for which he was looking, and he found them. As the spring comes on and advances into summer the pictures gain in freshness and warmth, but the author's mood is always the same. It is that of the lover of Nature who sees beauty and life in all their aspects and knows how to paint them.

The point of view taken by Mrs. *Ellen M. Mitchell*, in her *Study of Greek Philosophy* (S. C. Griggs & Co., Chicago, $1.25), is indicated by her dedication of it to the Kant Club of Denver, and her acknowledgment of indebtedness to the Concord School of Philosophy, Dr. W. T. Harris, and the histories of Zeller and Hegel. The book grew out of the studies of the author in connection with a woman's club in St. Louis, and afterward in Denver. Her verbal expositions gradually assumed written forms, and eventually came into their present shape; and the whole bears the impress of the thoughts of the other members of the clubs as well as of the author's own. Beginning with the assertion of the identity of philosophy and the history of philosophy, the author analyzes the character of the Greek philosophy, and then considers it from the beginning, in the pre-sophistic philosophy, through all its stages of development, and as expounded by the larger host of teachers whose names have become identified with much of the best of human thought, and whose influence has endured and is still strong. An introduction is furnished by William R. Alger, who glorifies philosophy as the supreme department, the most important and most attractive branch of knowledge, setting it above literature and science.

In *Ben Beor, a Story of the Anti-Messiah* (Baltimore, Isaac Friedenwald & Co.; Vicksburg, Miss., the author), the supernatural and the allegorical are mingled. The aim of the author, *H. M. Bien*, a rabbi of Vicksburg, Miss., has been to exhibit the agencies which are assumed to have been working during past ages to suppress the rights and liberties of the people; "upholding serfdom and superstition for the benefit of a few privileged classes." The persecutors and haters of man are called as a unit the Anti-Messiah, whose story is set forth under the name of Ben Beor. This character, called after the biblical Balaam Ben Beorz, who is endowed with an immortality like that of the Wandering Jew, appears in the ancient world as the instigator of the great evils which afflicted its nations; as the concocter and distributer of strong liquors and the stimulator of evil passions; as the chief agent in provoking the siege and destruction of Jerusalem, the Roman persecution of the Christians, the suppression of knowledge and free thought which marked the dark ages, the promoter of priestcraft and the Inquisition, and the upholder of despotism down to modern times. The invention of printing and the Reformation were antagonistic to his plans, and his power and his office ceased with the promulgation of the Declaration of Independence.

The fourth volume of Prof. *J. C. Branner's Annual Report of the Geological Survey of Arkansas for 1888* contains the geology of Washington County and the Plant List for the State. While it has been the plan of the survey to study and report upon geologic topics rather than upon geographic

areas, an exception has been made in the case of Washington County, because its geology embraces a complete section at the westernmost exposure in the State, across the lower carboniferous rocks from the base of the coal measure to the Silurian; and because the location of the State University at Fayetteville makes it desirable for the geology of the surrounding region to be worked up in detail for purposes of instruction. The economic results of the survey are not of great positive value, and Washington County will have to depend upon its other advantages, which are many and excellent, for its growth and prosperity. The report, which was prepared by Prof. F. W. Simons, is accompanied by a geological map. The Plant List is chiefly the work of Prof. F. V. Coville, with additional contributions by Prof. Branner, who remarks upon the clear distinction between the flora of the limestone and of the sandstone formations, as showing to how large an extent the distribution of plants is governed by the character of the soil.

The fourth part of Mr. *Harold Whiting's Course of Experiments in Physical Measurement* (D. C. Heath & Co.) consists of Appendices and Examples for the use of teachers. In the first appendix are described the laboratory, or room where the experiments are to be performed, which should be well lighted and uniformly heated, and should have good ventilation. The use of iron in construction should be avoided, on account of its magnetic influence, and special precaution should be taken to avoid vibrations. A basement is not suitable, or an attic. Such a room as is commonly used for lecture purposes is the most suitable—a two or three story room reaching from the first floor to the attic, and lighted on three sides, is the best. The arrangement of the tables, benches, and apparatus is considered, and the apparatus is described in detail, beginning with the most needed articles. In the third appendix, expenses, the most economical methods in dividing the classes and delivering the lectures, so as to get along with the fewest sets of apparatus and the smallest number of teachers practicable, are considered; and in the fourth appendix, the best methods of making the instruction given efficient and of permanent value. The rest of the volume is devoted to models of experiment, demonstrations of rules etc. First are examples of observations and calculations in a hundred experiments, illustrating the details to be regarded in each of the numbers and the manner of treating; there are three lists of experiments, intended to cover the ground required for admission to Harvard College, in both elementary and advanced physics. These are followed by discussion of the principles of finding the average values of variable quantities, the probability of errors, "proofs," and "useful formulæ," with, in conclusion, a full index to the whole series of books.

The Rev. *J. C. Atkinson*, Canon of York, publishes through Macmillan & Co., a collection of stories in the style of Jack the Giant Killer, and Jack and the Bean Stalk, entitled *The Last of the Giant Killers, or the Exploits of Sir Jack of Danby Dale*. They were written without any intention of publication, for the amusement of certain children belonging to different families, who were more or less interested in the district of which Danby Dale is a part. In nearly every instance the stories are based upon or connected with some local legend, local fact, or local habitation; and the relations are prefixed by a few remarks on the popular disposition to attach a superstitious significance to peculiar features in the landscape and to curious local incidents.

W. S. Gottsberger & Co. add a humorous book to their series of usually sober or classical romances in the shape of *A Little Tour in Ireland*, in which a visit to Dublin, Galway, Connemara, Athlone, Limerick, Killarney, Glengarrif, Cork, etc., is described by *An Oxonian*, with a vein of jollity pervading the story and a disposition to look upon the laughable side of everything—which are much heightened by Mr. John Leech's illustrations. The book is one from which the careful reader, by straining the substance from the froth, may get a fair and pleasing view of the country and its sights.

A collection of short stories by Count *Leo Tolstoi*, published by C. L. Webster & Co., includes *Ivan the Fool*, or the Old Devil and Three Small Devils, *A Lost Opportunity*, and *Polikushka*. The translation is direct from the Russian by Count Norraikov, who thinks that justice is not done to the author

in translations through the French or in direct translations by persons who know Russian only imperfectly. The first of the stories, Ivan the Fool, portrays Tolstoi's communistic ideas and the ideal kingdom he would establish in which each and every person should be a worker and a producer. A Lost Opportunity pictures Russian peasant life, with many of its peculiar customs. Polikushka describes the life led by a servant in a nobleman's court household, and marks the difference in the conditions and surroundings of such servants from those of ordinary peasants.

An exhibition of ten years' progress of the "New Learning" is made in Prof. *A. F. Chamberlain's* pamphlet on *Modern Languages and Classics in America and Europe* since 1880. It presents the views of numerous teachers and persons interested in education concerning the success with which the scheme for giving more relative attention to the modern languages has met in the United States, Great Britain, France, Italy, Hungary, Germany, and Norway and Sweden. Published at the office of The Week, Toronto.

Mr. *Henry George's* Open Letter to Pope Leo XIII on *The Condition of Labor* is a respectful, temperate reply to those parts of his Holiness's Labor Encyclical which bear on the doctrines held by the school of publicists of which the author is the most conspicuous representative. It is of value and interest to us chiefly because it presents a clear, succinct, and precise statement of what the doctrines of that school are, what they are seeking, and of the manner in which they purpose to promote their objects by peaceful agitation.

In a manual on *The Sextant and other Reflecting Mathematical Instruments* (D. Van Nostrand Company, 50 cents), Mr. *F. R. Brainard*, of the United States Navy, presents a compilation from various sources on the instruments concerned, and adds a few ideas and suggestions of his own, and of officers who have been associated with him; embodying also practical hints on the errors, adjustments, and use of the instruments.

In a manual of the handy Van Nostrand Science Series, *How to become an Engineer*, the theoretical and practical training necessary in fitting for the duties of a civil engineer are set forth by Prof. *George W. Plympton*, who supplements his views by quotations from the opinions of eminent authorities and full lists of the courses of study in the technical schools—including the Rensselaer Polytechnic Institute as an example of American schools, and several schools of England and the European continent. Price, 50 cents.

Light, an Elementary Treatise (Macmillan & Co., 75 cents), has been prepared by Sir *Henry Trueman Wood* with a view of providing such information as an intelligent student unfamiliar with natural science would require. In it are given an explanation of the modern theory of light and of the phenomena which are matters of common observation; descriptions of the nature of color and the manner of its production; accounts of the more important optical instruments and the principles of their action; an exposition of the chemical effects of light and their application in photography; and descriptions of the phenomena produced by polarized light and by fluorescence. The book is one of the numbers of Whittaker's Library of Popular Science.

Information about electric lighting, practical and theoretical, is given in the *Practical Treatise on the Incandescent Lamp*, prepared by *J. E. Randall*, Electrician of the Thomson-Houston Company, and published by the Bubier Publishing Company, Lynn, Massachusetts. It contains, in brief, the history of incandescent lighting, the philosophy and construction, with details, of the incandescent lamp, and observations on photometers and their use. The author estimates that 25,000 incandescent lights are made in the United States daily, or 7,500,000 a year, and he believes that the "life" of the lamp is more likely to be abbreviated than increased in the future, because consumers will grow more particular about the quality of their light, and will change their burners when they cease to be efficient instead of using them till they burn out.

Prof. *Wesley Mills*, believing that a dog is a useful member of the household and especially valuable in the city as a companion and means of instruction for the children, and recognizing the embarrassment city families labor under through not knowing how to manage with the animal in their narrow

quarters, has prepared a little book on *How to keep a Dog in the City*, which is published by William R. Jenkins, New York, for 25 cents. It supplies information respecting the details of the management of the dog from puppyhood up, including lodging, feeding, measures for cleanliness, care of his skin, exercise, training, and treatment of his ailments.

How to make a Trial Balance representing any number of accounts in less time than an hour is explained in a small book written and published at Baltimore, by A. Weinberg. The method is the result of much thought and study, and may, the author claims, be applied to a business of five thousand accounts as easily as to one of fifty accounts, with great saving of time and labor.

Two series of twelve charts each, published by the United States Signal Office, show graphically the probability of rainy days and the average cloudiness for each month in all the regions of the United States within the circle of observations of the several local signal stations. They are based on observations made from 1871 to 1888 inclusive, or for shorter periods at the more recently established stations. The percentages of rainy days (called such when precipitation to the extent of ·01 inch or more occurs) are calculated for each station and month from the average number of such days. The cloudiness charts are made up from eye-observations taken three times a day. They are expected also to show the sunshine by taking as sunshine the complement of the cloudiness. Such data, when well matured, a e of great value in the study of climate and its adaptability to different conditions and needs of health.

Three numbers of *The Quarterly Register of Current History* (Evening News Association, Detroit) have been published. The first number, February, 1891, contained a review of the history of the world during 1890. The second number, May, and the third, August, 1891, are devoted respectively to the history of the first and second quarters of the year. The matter is classified and arranged under the heads of International Affairs; Affairs in Europe, in Asia, in Africa, and in America; Record of Progress, and Necrology. The idea of the publication is an excellent one. The short view we have been able to take of the numbers does not suggest that anything of value is omitted, but shows several things of minor importance which, if they had been left out, would not be missed a year or two hence; and there is room for improvement in pruning and smoothing the articles, the present style of which is more like that of a daily paper than of a record made to last.

To the attempts to teach foreign languages in the way they are learned in Nature must be added the method of Dr. *Edward Pick*, in which the language itself is employed as the instrument, and is taught by comparison with the English before the grammar is learned. The author holds that remembrance is assisted most efficaciously in the study if we take the known as the starting-point of comparison with the unknown. In the study of foreign languages the known consists of those elements which we find in our own language, or in any other language familiar to us. Thus the knowledge of one foreign language facilitates the study of others. The usual method of studying foreign languages—beginning with grammar—"is contrary to the nature of the mind, because we begin with the unknown—nay, more, we begin with details unknown to us (the grammatical rules) of a thing equally unknown (the language)." In *Dr. Pick's Method applied to acquiring the French Language* (C. W. Bardeen, Syracuse, New York), the pupil is introduced to Voltaire's History of Charles XII, for the study of the French text, word for word and form for form, with the English translation.

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Ball, Robert. Star Land. London and New York: Cassell & Co. Pp. 376. Illustrated.

Ball, Robert. The Cause of an Ice Age. New York: D. Appleton & Co. Pp. 180. $1. Illustrated.

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Call, R. E. Tertiary Silicified Woods of Eastern Arkansas. Pp. 9. Reprint.

Cannizzaro, S., and Fabris, G. Tests for the Purity of Olive Oil. Boston: J. A. Hayes & Co. Pp. 41.

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Charts showing the Isobars, Isotherms, and Winds

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Cragin, T. W. New Observations on the Genus Trinacromerum, pp. 4; and On a Leaf-bearing Terrane in the Loup Fork, pp. 4. Reprints.

Crummell, Alexander. Africa and America. Springfield, Mass.: Wiley & Co. Pp. 466.

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Mason, W. P. Notes on Cases of Drinking-water and Disease. Pp. 10. Reprint.

Massee, George. The Plant World. New York: Macmillan & Co. Pp. 212. $1. Illustrated.

Maycock, W. P. First Book of Electricity and Magnetism. New York: Macmillan & Co. Pp. 133. 60 cents.

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Poole, Joseph. Practical Telephone Hand-book. New York: Macmillan & Co. Pp. 288. 75 cents. Illustrated.

Poole, W. H., and Mrs. Cooking for the Diabetic. New York: Longmans, Green & Co. Pp. 64. $1.

Pringle, Allen. Bibles and Religions out *vs.* in the Public Schools. Canadian Secular Union. Pp. 24.

Remondino, P. C. History of Circumcision. Philadelphia: F. A. Davis. Pp. 346. 50 cents.—An Instructive Case of Uræmia. Pp. 8. Reprint.

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Shaler, N. S. The Story of our Continent. Boston: Ginn & Co. Pp. 290. 85 cents.

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Sloane, T. O'Conor. Electricity Simplified. New York: N. W. Henley & Co. Pp. 158. $1. Illustrated.

Smith, J. B. Noctuidæ of Temperate North America. Smithsonian Institution. Pp. 80.

Smith, Oberlin. The Engineer as a Scholar and a Gentleman. Pp. 14. Reprint.

Stejneger, L. On the Snakes of the Genus Lichanura. Pp. 5.—Description of a New Species of Chameleon. Pp. 2.

Stevenson, J. J. The Chemung and Catskill [Upper Devonian] on the Eastern Side of the Appalachian Basin. Pp. 31. Reprint.

Torrey, Bates. Practical Type-writing. New York: Fowler & Wells. Pp. 156.

Upham, W. Geographic Limits of Species of Plants in the Basin of the Red River of the North. Pp. 32. Reprint.

Watts, C. A. The Agnostic Annual. London: W. Stewart & Co. Pp. 68. 6*d*.

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POPULAR MISCELLANY.

Ancient River Channels.—A remarkable contrast in the physical geography of the eastern and western coasts of the American continent is pointed out by Prof. Joseph Le Conte. The continent is bordered on both sides by a submarine plateau sloping gently seaward till it attains a depth of about one hundred fathoms, from which point the bottom drops off rapidly into deep water. This submarine plateau may be regarded as a sub-

merged coastal plain, and its margin as the true boundary between the continent and the ocean basin, or as the submerged continental margin. On the eastern coast the submarine plateau is trenched with submarine troughs running out from the mouths of the great rivers to the submerged continental margin and then opening into deep water. The best known of the channels are opposite the mouths of the Hudson and Delaware Rivers, Chesapeake Bay, and the Mississippi. Along the California coast the phenomena are different. The researches of Prof. Davidson have brought to light some twenty or more submarine channels on the coast from Cape Mendocino to San Diego, a distance of about seven hundred miles. But they have no obvious relation to existing rivers. They are not a submarine continuation of any system of river valleys on the adjacent land, but run in close to shore and abut against a bold coast, with mountains rising in some cases to three thousand feet within from three to five miles of the shore line, and wholly unbroken by any large river valleys. The channels of the Eastern coast are accounted for by supposing that they were always connected with the rivers opposite them, and that they have assumed their present positions by the operation of the changes of level to which the land has been subjected. But the disconnected positions of the Western channels can not be accounted for except as being the result of orogenic changes which have diverted the lower courses and places of emptying of the rivers since the channels were made. Prof. Le Conte's paper is devoted to the study of the nature and history of these changes.

Jupiter and the Comets.—Prof. H. A. Newton showed, at the meeting of the British Association, that if a comet or other small body should pass in front of Jupiter, the kinetic energy of the planet would be increased by the gravitational attraction between the two bodies, while that of the comet would be diminished, and might be diminished to such an extent as to cause it to form (though possibly only temporarily) a member of the solar system. On the other hand, if a comet, already a member of the solar system, pass behind Jupiter, the kinetic energy of the planet will be diminished and that of the comet will be increased, and may conceivably be increased under favorable circumstances to such an extent that the comet may no longer remain a member of the system. The author had calculated that of one billion comets from space crossing, in all directions, a sphere equal in diameter to that of Jupiter's orbit, about twelve hundred would come near enough to Jupiter to have their period so much diminished as to be less than that of the planet.

The Baths of the Accursed.—Hammam Meskoutine, or the Baths of the Accursed, are a famous bathing-place and health resort not far from Constantine in Algeria. They are but a few minutes' walk from the railway station. The first object of interest within a quarter of a mile of the station is a superb hot waterfall, whence the vapors fly away abundantly. "Yet," says a writer who describes it, "it is not all of water. For the most part it is rigid, like a thing of ice. It is, in fact, mainly a petrifaction. The calcareous deposit in the hot spring above has incrusted the rocks, so that they have the corrugated appearance and something of the color of barley sugar. Here and there, over and between the still masses, there is an ooze or trickle of warm water, adding to the work already done. Grass and flowers grow well by the sides of this nutritious waterfall, though the whitened soil in the neighborhood does not seem adapted for vegetation of any kind. You climb to the level of the cascade, and then see, close by, a number of odd-looking cones and columns standing up from the blanched surface of the ground. The soil is hot to the hand, and you tread with an echo." The springs bubble up with a temperature of more than 200° Fahr. A litter of egg-shells and fowls' feathers by the edge of them tells of the purpose they serve to the residents of Meskoutine. Here the dinner is cooked, and the clothes are washed in one or another of the little basins by which the springs eddy up to the daylight. Though the Arabs give the baths an impolite name, and tell various weird tales about them, they love them well. The cones look like a procession of gigantic phantoms suddenly petrified. Some are six or seven feet in height, and some are fourteen or fifteen feet. They mark the sites of

ancient springs now subsided. At one time each of these cones was but the mere rim or lip of a basin in which the hot water bubbled as we see it at the top of the cascade. Thus the water continued to boil upward in jets, like the geysers, for centuries, gradually, by the deposit of lime which fell from it, raising its lip. At length the subterranean force that impelled it vertically weakened. The cone had attained its full stature. According to the Arabs, however, the cones are deaf, dumb, and blind genii in whose charge Solomon put the baths when he is supposed to have created them for all the world. The worthy guardians, who still think King Solomon is alive, continue to keep the baths warm as they did at the first for the use of the king's subjects. It is supposed to be a matter of great difficulty to announce to these genii the fact that their master is dead. The inference is, therefore, that they will continue to warm the baths to the end of time. Various other stories are told to account for the origin of the baths.

Lepers in the Middle Ages.—Leprosy was common in England and continental Europe some five hundred years ago, and those who were afflicted with it were subjected to treatment which would now be considered cruel. Institutions for the segregation and treatment of the diseased, erected by the Church or by the aid of pious donors, were to be found over all England; and at one time there was a leper hospital or village near every town. According to Prof. Simpson, there were in the year 1226 two thousand lazar-houses in the small kingdom of France. "In the thirteenth and fourteenth centuries," says an English writer, "a leper was not allowed to hold property, was deemed incapable of making a will, and lost all the privileges of citizenship. He was hunted from the towns and driven from the dwellings of men; he was forbidden to drink from the running stream, lest he should defile it, and it was unlawful for him to touch things that were used for food by man. Anything was deemed good enough for the leper." When a man was supposed to have leprosy, he was examined, and, if the disease was found upon him, was banished from society, after enduring a service at the church resembling the funeral ritual, and sometimes embodying a part of it. If a man was wealthy, he might buy himself an exemption from the extreme disabilities, as did the abbot Richard de Wallingford, who was able, with great difficulty, to keep his position. The hospitals maintained by the Church did much to alleviate the woes of lepers. The regulations of the Hospital of St. Julian, which were drawn up in 1344, have been preserved. Though strict, they were not hard. Among them was an exhortation to avoid slander and cultivate brotherly love and true charity. Each leper was allowed seven loaves of bread a week, five of white and two of brown, made from corn "just as it had been thrashed from the sheaf." Every seventh month he had fourteen gallons of ale or eight pence; on Christmas-day, forty gallons of ale or forty pence, two quarters of pure and fine corn, and his share of fourteen shillings, to be applied to the purchase of mufflers. On St. Martin's day each one had a pig from the common herd, the patients taking choice in the order of seniority of admission, or a money equivalent in case pigs were scarce. Other periodical allowances were a bushel of beans or peas every winter; a quarter of oats on the 14th of February; two bushels of salt, and four shillings for clothing, on the 24th of June; a penny on St. Alban's, St. Julian's, and Easter days; a half-penny on Ascension-day "for the taking away from themselves of dirt"; and flour for pancakes on Shrove Tuesday. With these gifts they were commanded to be content.

Offices of Forests.—A writer who narrates the history of the woods and pastures of Lynn, Mass., in the Transcript of that city, says that the "Lynn woods have had three periods of usefulness. Down to 1706 they furnished pasturage and timber and shelter to the village. In their second period, covering the life of the town in its shifting from the pastoral to mechanical pursuits, they were still useful, although restricted to furnishing fuel to the inhabitants. As time went on, and cheap coal came in with the ever-advancing density of population, it seemed as if the slaughtering brick-maker and fire-fiend would render the woods a desert and a menace to our fair town." But a period of greater usefulness, according to Garden and Forest, has come. The inhab-

itants of cities require pure water, and the people of Lynn have wisely determined to protect and preserve the abundant supply which still flows from the springs that watered the cattle of the Puritans, and these woods now perform their noblest duty, in furnishing the great city with water, oxygen, and sylvan beauty for the repose of its inhabitants.

Fossil Insects.—The publications of the last ten years on fossil insects comprise, according to Mr. S. H. Scudder's review, about one third of a complete catalogue of papers on the subject. This literature records some of the most important discoveries that have been made in this field. Passing the discovery of Silurian scorpions in several parts of the world, we have, first, Brongniart's discovery of the hexapod, *Palæoblattina*, in the Silurian of France, as yet the only known true insect in that system. Next is the remarkable Devonian insect fauna in New Brunswick, first announced before 1880, but only fully published, with figures of the species, then. With these must be classed the Devonian myriapods, the earliest known members of that group, elaborated by Peach. In the Carboniferous period we have the abundant forms of Mazon Creek and other deposits in the United States, which include so extraordinary a number of blattarians that Mr. Scudder calls it, so far as its insect fauna is concerned, "the age of cockroaches." These discoveries are even more than paralleled by the similar discoveries of M. Brongniart in France, equally characterized by multitudes of cockroaches. There the principal discoveries in the Palæozoic series have been accompanied by the publication of many striking forms which indicate the ancestral types of living insects, or by the better elucidation of types already known but whose significance had not been understood. A new era has been begun in the study of the earlier types, in that the subjects have been treated in more than a scattered way, by fuller discussions, and by attempts to systematize. Our knowledge of Mesozoic insects has been likewise much enlarged. Of Tertiary insects, the earliest are to all general intents and purposes identical with those of to-day, although they differ no doubt specifically, and to a considerable degree generically. Most of those so far recovered from temperate regions indicate a warmer climate in their time; but, taken as a whole, the grand features of insect life appear to have been essentially the same since the beginning of Tertiary times. Of the insects of this period, the Florissant deposit alone of the Western United States is as productive, if we exclude the insects found in amber, as all the Tertiary fields of Europe taken together. Last year the author found that the strata of a considerable tract of country in western Colorado and eastern Utah were packed with fossil insects as closely as at Florissant. "Whether these new localities will excel or even equal that place in the variety of their fossil treasures is yet to be determined; but there can hardly be any doubt that we shall soon be able in our Western Territories to rehabilitate successive faunas as successfully as has been done with many of our vertebrate types, and as has not yet been done for insects in any country in the world." Insects have now been found, too, in a score of places in our Carboniferous series.

Ancient Superstitions in Italy.—In a paper at the International Folk-lore Congress on Modern Tuscan Tradition, Mr. Charles G. Leland spoke of a mountainous district, the Romagna Tuscana, between Forli and Ravenna, in which the peasantry have preserved old customs and traditionary lore to a degree for which there was no parallel elsewhere in Europe. There are certain families in which witchcraft is especially cultivated, among whom the old traditions and names of the gods still live. There is ten times as much belief in the superstitions as in the Catholic religion; and when people are in trouble, though they first tried the saints, they always found sorcery and spirits best in the end. The basis of the cult was a peculiar polytheism, or a worship of the spirits called *folletti*. These spirits generally bear the names of old Etruscan gods, mostly very little changed, or of the old Roman minor rural deities. First among them is Tinia, the *folletto* of thunder, lightning, and storms. There is also an herb called *tigna*, identified with this spirit and much used in magic to repel Tinia when he injures crops. The spirit of

the vineyards, wine-cellars, and wines, whose name, Fafian, is but little changed from Fufluns, the ancient Etruscan Bacchus, is described as "enchantingly beautiful" and given to good-natured mischief. When the peasants are gathering grapes, he comes invisibly and knocks their panniers all about; but if this is taken pleasantly, he replaces everything, and then his ringing laughter is heard. Sometimes he falls in love, and, of course, always woos successfully. Teramo is the spirit of merchants, thieves, messengers, and carrier-pigeons, and corresponds with Turnus, the old Etruscan Mercury. Maso or Mas is Mars, not the god of war, but his Etruscan prototype, a god of crops and fertility. Diana preserves to this day her title of queen of the witches. The great mediæval writers declare that all the Italian witches asserted that they did not worship Satan, but Diana and Herodia. Marcellus of Bordeaux, who was court physician to the Emperor Honorius in the fourth century, collected and recorded a hundred magical cures which he had gathered among old women and peasants. Of these, Mr. Leland by dint of much inquiry had found fifty in practical use, and had recovered some of them in a more perfect form than that given by Marcellus. Through all this lore there runs the thread that all disorders and ill luck and earthly mischances are caused by witchcraft, and must be cured by Christian saints or heathen sorcerers, of which the latter are preferred.

Allotropism in Alloys.—In his presidential address before the Chemical Section of the British Association, Prof. Roberts Austen spoke of the consequences of allotropic changes which result in alteration of structure as being very great. The case of the tin regimental buttons which fell into a shapeless heap when exposed to the rigorous winter of St. Petersburg is well known. The recent remarkable discovery by Hopkinson, of the changes in the density of nickel-steel (containing twenty-two per cent of nickel) which are produced by cooling to 30°, affords another instance. This variety of steel, after being frozen, is readily magnetizable, although it was not so before; its density, moreover, is permanently reduced by no less than two per cent by the exposure to cold; and it is startling to contemplate the effect which would be produced by a visit to the arctic regions of a ship of war built in a temperate climate of ordinary steel, and clad with some three thousand tons of such nickel-steel armor; the shearing which would result from the expansion of the armor by exposure to cold would destroy the ship. The molecular behavior of alloys is, indeed, most interesting. W. Spring has shown, in a long series of investigations, that alloys may be formed at the ordinary temperature, provided that minute particles of the constituent elements are submitted to great pressure. W. Hallock has recently given strong evidence in favor of the view that an alloy can be produced from its constituent metals with but slight pressure, if the temperature to which the mass is submitted be above the melting-point of the alloy, even though it be far below the melting-point of the more easily fusible constituent. A further instance is thus afforded of the fact that a variation of either temperature or pressure will effect the union of solids.

The Instincts of Cattle.—Many habits of the lower animals can be explained by analogy with our own behavior in similar circumstances and still more with that of savage men. Thus the tenderness and ingenuity that a cow shows in caring for her calf, and the fierce courage that she displays in its defense against foes from which she would flee if alone, all find their counterparts in human life. Several instincts that are more difficult to account for are discussed by Mr. W. H. Hudson, in a recent number of Longman's Magazine. This writer accounts for the angry excitement shown by cattle on the appearance of a red cloth as an outgrowth of curiosity. Were a red flag displayed in a field by itself, the animals would surround it with every sign of interest and curiosity; but should a man drape himself in it, the bolder would attack him, not on account of the color, but because the man had drawn their attention irresistibly to himself. In regard to the unerring detection by cattle of the spot where blood has been spilled, the furious fighting over it by the stronger males, the strange anxiety of the whole herd to survey it, and above all the weird horror expressed in the discordant

note that the bellowing at once assumes, Mr. Hudson supposes that "their inherited memory associates the smell of blood with the presence among them of some powerful enemy," and that their attacks on each other result from the lack of any visible foe. This seems reasonable, and it might be worth while for Mr. Hudson to consider whether a better explanation of the excitement caused by red objects could not be found by connecting the impression produced by the sight of red—the color of blood—with that produced by the smell of blood. To the same blind terror and the same invisibility of cause is attributed the impulse of cattle to gore or trample to death a disabled companion—ability to discriminate between distress and the cause of distress being wanting. Of a very different origin is the persecution of the weakly members of a herd by the stronger. This comes from the instinct of self-preservation that prompts the individual animal to establish ascendency over as many of the herd as it can.

The Preparatory Stage in Education.—The young mind, with all its latent powers, with all its individual characteristics, is likened by President J. M. Coulter to an uncultivated field that must be drained and broken up and harrowed, to be ready for the seed; and the seed is one's specialty, which is to be planted when the ground is ready. This popular cry for a "practical education" asks us to omit the preparation of the soil and plant the seed at once, that there may be no loss of time. This figure seems to express the proper relationship between the general training or preparation which we call "education" and the special training or apprenticeship which looks directly to one's life-work. It is these two stages which are distinct in method and purpose that are ignored in the popular reasoning. One prepares the soil, the other sows the seed; the one reduces the metal, the other fashions it to its special use; the one develops the muscle, the other turns this developed power to some definite purpose; the one weaves the cloth, the other cuts and fits it. Think of shaping an axe from unreduced ore; of wielding a sledge-hammer with weak and flabby muscles; of cutting clothes from an unworked fleece, and you have the sort of reasoning used by "practical" men concerning what is called "practical" education. The author thinks it is apparent that mental muscle may be developed without a single item of information being obtained as such; and that it may often be cultivated in a pleasanter, more even, and scientific way, if the utilitarian idea of obtaining information be not constantly present. Education, then, being the development of mental muscle, the period of preparation, we are confronted with the question, "What is a practical education?" not in the popular meaning of the term, but really. Plainly, it is that kind of education which will bring about the development of this mental muscle, this preparation which is to bring ability to grasp one's specialty and the problems of life. Hence, studies become tools, the agricultural implements, not the seed; the means, not the end. No study in our ordinary, unprofessional schools has any right to be other than a means; the subject itself entirely lost sight of in its application; the grindstone forgotten in the sharpening of the tool.

The Uses of Potlatch.—The Northwestern Indian custom of potlatch, from Dr. Boaz's description of which in a report to the British Association we gave a condensed extract in the May number of the Monthly, is regarded by the Hon. Horatio Hale as something essentially different from the parade of wasteful and ostentatious profusion which it superficially appears to be. It is, he says, "a method most ingeniously devised for displaying merit, acquiring influence, and at the same time laying up a provision for the future. Among these Indians, as among all communities in which genuine civilization has made some progress, the qualities most highly esteemed in a citizen are thrift, forethought, and liberality. The thrift is exhibited by the collection of the property which is distributed at the gift-feast; the liberality is, of course, shown in its distribution; and the forethought is displayed in selecting as the special objects of this liberality those who are most likely to be able to return it. By a well-understood rule, which among these punctilious natives had all the force of a law of honor, every recipient of a gift at a potlatch was bound to return its value, at some future day, twofold.

And in this repayment his relatives were expected to aid him; they were deemed, in fact, his sureties. Thus a thrifty and aspiring burgher who, at one of these gift-feasts, had emptied all his chests of their accumulated stores, and had left himself and his family apparently destitute, could comfortably reflect, as he saw his visitors depart in their well-laden canoes, that he had not only greatly increased his reputation, but had at the same time invested all his means at high interest, on excellent security, and was now, in fact, one of the wealthiest as well as most esteemed members of the community.

An Overlooked Mode of Iceberg Formation.—To the familiar explanation of the formation of icebergs must be added another. Mr. Israel C. Russell, in recounting his expedition to Mount St. Elias, says that the foot of a glacier extends out under the muddy water, sometimes for a thousand feet or more, in front of the visible part of the ice-cliffs. When this extension of the ice-foot has reached the point where the buoyancy of the ice at the bottom exceeds its strength, huge pieces break off and rise to the surface. The sudden appearance of these masses of ice is always startling. "At first it seems," says Mr. Russell, "as if some huge sea-monster had risen from the deep and was lashing the waters into foam." Soon it can be seen that a blue island has appeared above the surface, carrying up hundreds of tons of water, which flows down its sides in cataracts of foam. The fragments which rise from the bottom in this manner are usually larger than those broken from the faces of the ice-cliffs, sometimes measuring two hundred or three hundred feet in diameter. Their size and the suddenness with which they rise would insure certain destruction of a vessel venturing too near the treacherous ice-walls.

Artificial Globular Lightning.—M. Planté has used his secondary batteries to reproduce on a small scale the phenomenon of globular lightning. M. von Lepel has shown that it can be obtained also by means of static electricity given by an induction machine. When two small copper wires from the poles of a strong machine are held at a certain distance from the opposite faces of a plate of mica, ebonite, or glass, small luminous red balls will be seen moving here and there, at times slowly, at others rapidly, and sometimes in a stationary position. The most remarkable effects are got with a plate of glass or disk of paper rubbed with paraffine. M. von Lepel believes that the vehicles of the luminous phenomena are small particles of liquid or dust. A slight current of air will remove the spherules, which will disappear faintly whistling. The experimenter remarks, further, that the phenomena are of weak tension. When this is increased, the luminous balls are no longer obtained, but instead of them the ordinary spark-discharge.

Contamination of Graveyard Soil.—As a part of the inquiry as to whether the soil of graveyards is liable to become infectious and dangerous, Dr. Justin Karlinski, of Konjica, Herzegovina, has undertaken to determine whether the organs of the body undergo any change in temperature during the natural process of decomposition after burial in the earth, and especially whether any difference appears in the case of infected subjects. His results show that the putrefactive process is invariably accompanied by a rise of temperature above that of the soil around, and that the rise is higher when the parts examined have been taken from bodies that have succumbed to infectious diseases than from other bodies. He found that typhoid bacilli may retain their vitality in the decomposing spleen for three months, and are annihilated only by rapid putrefaction. The author says that he had previously shown that typhoid bacilli could retain their vitality for five months in soil, but that if the earth were thoroughly saturated with rain-water they are destroyed in from seven to fourteen days. The part played by the soil in the origin of epidemics should not, he thinks, be underestimated, since typhoid bacilli can exist in water only for a comparatively short time.

Melanesian Ghosts.—According to Dr. R. H. Codington, in his studies of their Anthropology and Folk Lore, the Melanesians have no conception of the devil as an evil spirit, but are possessed by the belief in a

supernatural power or influence called *mana*, which shows itself in physical force, or in any kind of excellence which a man may possess. "This *mana* is not fixed in anything, and can be conveyed in almost everything; but spirits, whether disembodied souls or supernatural beings, have it and can impart it; and it essentially belongs to personal beings to originate it, though it may act through the medium of water or a stone or a bone. All Melanesian religion consists, in fact, in getting this *mana* for one's self, or getting it used for one's benefit—all religion, that is, as far as religious practices go, prayers and sacrifices." The sacrifices are different in different places. In the western islands the offerings are made to ghosts, and are consumed by fire as well as eaten; in the eastern islands they are made to spirits, and there is no sacrificial fire or meal. In the former, nothing is offered but food; in the latter money has a conspicuous place. Notwithstanding our association of idolatry with these people, Dr. Codington gives it no place in his account of their religion. Their belief is all in ghosts. There are land-ghosts and sea-ghosts, of which the latter have the more important place. At Wango, in the Solomon Islands, there was a canoe-house full of carvings and paintings representing native life, among them a canoe attacked by ghosts that haunt the seas. Two of them are composed as much as possible of forms of fishes—their spears and arrows long-bodied gar-fish and flying-fish. Even sharks have ghosts. In the volcanic islands it is generally believed that the souls of the dead ascend the mountain and are received within the craters by the ghosts which assemble to welcome the new-comer.

The "Rare Earths" in America.—Mr. Waldron Shapleigh exhibited at a recent meeting of the Franklin Institute some forty specimens of salts of what are called the rare earths, with minerals from which they are obtained, viz.: samarskite, zircon crystals, and monazite sand from North Carolina, monazite sand from Brazil, gadolinite from Texas, and allanite from Virginia. This was the first time the salts of praseodymium and neodymium have been shown and probably separated in this country; the separation of these elements is long and tedious. The specimens shown had undergone nearly 400 fractional distillations, and had been in a state of constant preparation since early in 1888. Tons of cerite and monazite sand had been used, and tons of the salts of cerium and lanthanum obtained, but the yield of praseodymium was only a few kilogrammes. The percentage of neodymium was much higher. Zirconium, lanthanum, and cerium should no longer be classed among rare earths, as hundreds of tons of ores from which they are obtained have been located in North Carolina, and there seems no end to the deposits of monazite sand, one of the richest ores, and containing most of the rare earths. In Brazil it does not have to be mined, as it is in the form of river-sand. In North Carolina it is found in washing for gold. Should the arts, trades, or manufactures create a demand for these so-called rare earths, Nature could readily supply it from these two localities. Thorium and yttrium minerals are not so easy to obtain, but they have recently been found in quantity in North Carolina and Texas.

Cultivation of the Poppy.—The poppy is cultivated for opium in a region of India about six hundred miles long and two hundred miles wide. The plants come into full flower in February, when they are some three or four feet high. Each stem produces from two to five capsules, about the size of a duck's egg. Previous to piercing these capsules, the petals of the flower, now beginning to fall off, are carefully collected. They are formed into circular cakes from ten to fourteen inches in diameter, and put into shallow earthen vessels which are heated over a slow fire, and are eventually used as shells or coverings for the drug. When the capsules have reached their highest development, the ryot visits his poppy-field in the afternoon and scarifies each capsule from top to bottom, adding sometimes a horizontal cutting. The juice at once begins to exude; milky white at first, but afterward taking on a pinkish tinge. The exudation continues during the night. If there is no wind and abundance of dew, the return is favorable. A westerly wind and cloudy atmosphere diminish the yield.

At an early hour the next morning the ryot again repairs to the field and collects the thickened juice from the capsules. The juice is next emptied into an earthenware pot, and the ryot is expected to expose it every day to the air, but not to the sun; to turn over the mass daily, so as to insure its being thoroughly dried; to keep it free from impurities or adulterations; and to bring it up to the highest standard of consistence and strength. When he has persevered with this process for three weeks or a month he delivers the raw opium at the factory. A dark, coffee-colored fluid, called *pussana*, exudes from the juice when it is fresh, which contains many of the active principles of the drug, and is dealt with separately. Besides the collected petals which form the envelope of the drug, and the *pussana*, the ryot has other sources of profit in the poppy. The stems and leaves of the plant are left till they become thoroughly dried up under the hot winds of April and May. They are then removed, broken up into a coarse powder, and used for the packing of the cakes. The oil is used for cooking and lighting. The seeds are like caraway and are sold as comfits; and after the extraction of the oil a dry cake remains, which is given to cattle or sold for medicinal purposes.

Time-reckoning on the Congo.—According to an account of the geography and meteorology of the natives of the cataract region of the Congo, given in the *Mouvement géographique*, the day is the solar day, in the length of which no variation (the range being only about forty minutes) is recognized. It is divided into four parts of three hours each, which are indicated by stretching the arm or pointing to the east for sunrise; 45° toward the east for nine o'clock; toward the zenith for noon; 45° toward the west for three o'clock, and horizontally toward the west for sunset. Each hour has its name, that for sunrise meaning "early," and that for sunset, "the sun is dead." If a native is asked how long it will take to go to a certain village, he will answer by pointing to where the sun stands at starting, and toward where it will be when the point is reached. Thus he indicates the number of hours by the astronomical angle corresponding with them. Four days form a week, and each day has its name. Public markets are distinguished by the name of the day on which they are held, and of the chief, village, or group of villages that control them. Seven four-day weeks form a month, which corresponds with the lunar month. Long durations of time are expressed in moons; the black does not take account of years. Although he distinguishes the seasons and recognizes their periodicity, he has no fixed point by which to determine the revolution of the sun. The five seasons of the Congo are that of abundant and continuous rains (from the middle of February to the middle of May); that of the end of the great rains and the beginning of the dry season, when the grass grows high (middle of May to middle of July); the dry season, continuing till the middle of September—also the season of great hunts; the beginning of the lesser rainy season, when the sapotas begin to grow (middle of September till the end of November); and the season of decreasing rains, or lesser dry season, when the sapotas are eatable (December, January, and early February). The phases of the moon are understood. The new moon is called the child moon, and the moon at its last quarter the dead moon. The blacks know that the new moon is the same that appeared in the preceding month, but they have no explanation for the phenomenon. They have no notion concerning the stars, further than to recognize the brightness of Venus and give it a name, and to name the constellation of the Three Kings. Atmospheric phenomena — rains, droughts, thunder, rainbows, halos, etc.—are attributed to the action of the spirits invoked by the fetich-priests.

Evolution on the Railroad.—It is most interesting, says Mr. W. Armstrong Willis in the Gentleman's Magazine, to trace how tenaciously the first railway managers in England clung to the traditions of coaching. The builders of the first railway carriages made no allowance for the changed mode of progression and motion which was introduced with the steam-engine. They retained the short, narrow, stuffy body of the stage-coach, set it upon four wheels of another make, and then attached it to the engine as to a new, enlarged kind of horse. With the increased

speed of traveling the motion became intolerable, and, when a high rate of speed was reached, few people could keep their seats. By degrees, but very slowly, these things were improved. Better ventilation was insured, more wheels were added, and the carriages were enlarged; doors and windows were so constructed as to keep out the clouds of dust that choked the traveler on badly made and ill-kept lines. The same principle of evolution which has turned the old stage-coach into the comfortable saloon-carriage has been at work in every department of railways and their management, and the highly intricate and important system of modern signaling springs from a most simple beginning. Shortly after the opening of the Stockton and Darlington line, which was the earliest line constructed, one of the station-masters is traditionally said to have adopted the simple expedient of putting a lighted candle in the window of the station-house when it was necessary for the train to stop. When the Liverpool and Manchester Railway was first opened, in 1830, the only means of signaling the trains was a flag by day and a lamp by night. The first advance to modern signaling began about four years after the line had been opened, when stout posts were provided upon which lamps were placed by the pointsman. Nowadays the signalman's cabin is the center from which all signaling radiates.

Rainfall by Explosion.—Reviewing the theories of artificial rain-making, Prof. E. J. Houston draws the general conclusions, in view of the present state of meteorological science, that rain can never be made to fall at will by mid-air explosions on any part of the earth's surface, irrespective of the climatic conditions there existing; but during certain meteorological conditions, mid-air explosions may result in rainfall over extended areas; that the liberation of energy necessary for such rainfalls is due not to the mid-air explosions, but to the energy stored up in the moist air from which the rain is derived; that the meteorological conditions which must exist for the successful action of mid-air explosions would probably in most though not in all cases themselves result in a natural production of rain; that a comparatively high difference of electric potential between different parts of the air, or between the air and the earth, is possibly favorable, when taken in connection with other meteorological conditions, for artificial rain-making; and that an undirected mid-air explosion is not as likely to produce rain as an explosion in which the main tendency of the energy liberated is to cause a general uprush of the air. Among the "certain meteorological conditions" mentioned in this summary is that in which the air is in a state of very unstable equilibrium, when a slight determining cause may result in the liberation of the stored-up energy, with a resulting heavy rainfall. In such cases it may appear that there are no reasons why an explosion in mid-air should not be followed by rain. In this case rain might be eventually caused without artificial aid. A condition in which heavy rains might be artificially produced by mid-air disturbances, when without them there would be none, may exist when a layer of warm, moist air exists between the earth's surface and a higher layer of cold, moist air, separated by a comparatively thin layer of air, and other conditions are such as to maintain the two layers separate. The breaking or piercing of the intermediate separating layer might then permit such an uprush of the warmer air as would result in the formation of a true storm center and a heavy rainfall.

Weddings among the Shushwap Indians.—Dr. Franz Boaz, in his report to the Hon. Horatio Hale for the British Association concerning the northwestern Indian tribes of Canada, describes from native accounts the marriage ceremonies of the Shushwap as follows: "A young man who wishes to marry a girl takes a number of horses and other property that is considered valuable, and offers it to the father of the girl he wishes to marry. The latter, before accepting the price offered, invites his whole family to a council and asks their consent. If they agree to accept the suitor, and the price he has offered for the girl is satisfactory, they tie the horses to their stable and take the other goods into the house, as a sign of their willingness. After this the young man may take the girl without further ceremonies. After the marriage the bridegroom and his family go on a hunting expedition, and try to obtain

as much game as possible, which is to be given to his father-in-law. The latter dresses the meat and invites the whole tribe to a feast. Then he and his family in their turn go hunting, and present the game they have obtained to the young man's father, who gives a feast to the whole tribe. At this time the girl's father returns all the payments he has received to the young man's father. For a number of days the couple live with the girl's family. When the young man goes to reside with his wife he asks all his friends to support him, and they give him presents of food and clothing. The latter he puts on, one suit on top of the other, goes to his father-in-law, and gives him all the property he carries. The latter distributes this property among the whole tribe according to the contributions every one has made. Then the young couple remove to the young man's family; and before leaving her father's house the bride is fitted out with presents in the same way as the young man was when he came to reside with her family. This is a present to the young man's father, who also distributes it among the tribe."

Some Characteristics of Waves.—The friction of the wind upon the sea-surface, the convulsions of deep-seated earthquakes, and the attraction of the heavenly bodies, give rise to three different kinds of sea-waves. If the wind blows directly parallel to the sea-surface, says a writer in Chambers's Journal, the friction may cause an ocean-current without wave-disturbance. As a rule the direction of the wind is inclined to the sea-surface, and its immediate effect is to produce a depression, which relieves itself by means of a wave to leeward and another to windward. This latter elevation is opposed by the wind, and gradually dies away, while the leeward wave is correspondingly accelerated. Each undulation shelters the water under its lee from the wind, which consequently impinges upon the sea a little in advance of the newly formed wave; and thus we get a series of parallel ridges and hollows, provided the wind remain steady in direction and intensity. There is no necessary connection between the advance of a wave and the forward movement of the water composing it, as may be seen by running the fingers along the keys of a piano. An inverted wave travels along, but the keys merely move up and down. Similarly, a wave may often be observed running along the ripe ears of golden grain while the stalks are firmly rooted in the soil. The onward progress of a sea-wave is easily perceptible, and by watching some light substance floating on the surface the fact is revealed that the water is not moving with the same velocity as the advancing wave. Should the wind direction suddenly change, a new series of waves will be generated, and cross-seas soon confront the mariner. Hence it is that in a cyclone, or revolving storm, where the wind is frequently changing, there are high waves rolling along from various directions, each as distinct as the ripples in a river, which cross one another without swerving from their course. Waves become short and abrupt in shallow water, and are far more dangerous to shipping than the long, regular billows of the ocean. It is probable that the greatest slope of a wave in open waters does not exceed thirty degrees, and frequently not more than fifteen degrees. Waves raised by the friction of the wind upon the water are relatively superficial. In heavy gales, however, lower depths become troubled, and the undulations more and more imposing. Occasionally an exceptionally large solitary wave is met with, advancing in awe-inspiring grandeur, its white crest towering high above all its fellows. Such ocean giants may be due to the fact that the elevations of series of waves having different lengths happen to coincide; or may be caused by squalls of wind, which are sometimes as terrible in intensity as they are sudden in formation.

The Wagging of the Dog's Tail.—Prof. Eimer, in his work on Organic Evolution, is not able to explain why the dogs of Constantinople erect the tail and carry it upright, while the ancestral wolf and the jackal carry it hanging down. Dr. Joseph L. Hancock suggests, in the American Naturalist, that the reason may be found in the fact that as the dog becomes domesticated it is prone to use the tail as an organ for expressing mental states—wagging it when pleased, dropping it between the legs when disappointed or frightened. The ancestral wolf

carries it hanging down, because in that position it is less conspicuous and better eludes detection. A family of wolves playing together undisturbed occasionally carry their tails curled upward. By degrees the tail acquires naturally the upright position as a result of coincident evolution of the mind of the wolf by domestication and of the slow adaptation of the appendage as an organ of expression. The cessation of natural selection in the domestic dog would give the tail greater freedom of motion without detriment to life; and artificial selection modifies it into various shapes.

Sulphur in Sicily.—According to the report of the United States consul at Palermo, there are now about three hundred sulphur mines in Sicily. The deposits are estimated to amount to about 30,000,000 tons, and the annual production to 400,000 tons. The royalties vary from twelve to forty-five per cent, according to the quality of the ore and the facilities for producing the sulphur, and average about twenty-five per cent. The external indications of the presence of sulphur are the appearance of gypsum and sulphurous springs. When the miners detach the ore from the surrounding material, vast cavities are often left which have to be supported on pillars of rock, and frequently give way with disastrous results. Seven different qualities are recognized, and determined by color. The mines have declined in prosperity since the extraction of sulphur from iron pyrites has come into use, and two thirds of them are represented to be at the point of suspension.

Cause of Chinese Emigration.— The main cause of the emigration from China, which is filling all other countries with apprehension, is traced by a Dutch colonial officer in the East Indies, not to the excess of population, but to the poverty of the soil in the provinces whence the emigrants come. The mass of the emigration is from the bare mountainous valleys of the eastern part of China, where the soil yields but little and the rainfall is slight. Disafforestation, making wood scarce and dear, is another factor in the matter. The author believes that as soon as China earnestly sets itself to the task of constructing railways and other great works the stream of emigration will be stopped; for the people will find in the interior of their own country the work and means of livelihood which they now seek for elsewhere.

University-extension Lectures on Science.—Arrangements have been made, in connection with the English university-extension movement, for one month's residence during the long vacation of extension students within the university precincts, where lectures will be given them on the subjects of their studies. The lectures for 1891 included a discussion of the criticism of Weismann's theory of heredity, by Mr. Poulton; the functions of the heart, by Mr. Gotch; the benzene ring, by Prof. Odling; a course of practical chemistry, under the supervision of Mr. Marsh; practical instruction in geology, by Prof. Green and Mr. Badger, with excursions; practical astronomy; four lectures on the application of science to the art of agriculture; the management of poultry; and manures.

NOTES.

A practical paper on Some Means of Health in School-houses is contributed to the 1890 Report of the Wisconsin Board of Health by Hon. W. D. Parker. One of the arrangements that Mr. Parker strongly commends is the "dry-air closet," so called because a current of dry air, coming from the ventilating flues of the building, is passed through the vault and carries off all the moisture from it, leaving only a small quantity of dry, inoffensive solid matter, which can be shoveled out. This result, he says, is almost incredible, but has been established by sufficient tests.

The fact that the science relating to electricity has no name of its own is noted by the editor of Our Language, who proposes that it be called "electrics." The pair of words, "electrics" and electrician, would be in analogy with optics and optician, mechanics and mechanician, mathematics and mathematician, and many others. At present the word electricity performs two functions similar to those which are separated in the case of light and optics, heat and thermotics, sound and acoustics.

An instance of a spider catching a small mouse, very similar to one published in the Monthly for May, 1890, comes to us from Columbus, Ohio. The mouse was found by Mr. W. J. Dawson suspended by a cable

of spider's threads under a counter in his grocery-store, 511 West Broad Street. It had been hoisted three inches from the floor, and the spider, which was no bigger than the end of a lead-pencil, was by dint of hard work very slowly hauling it up further, the captive being alive and struggling. After about an hour the cord was broken and the mouse was carried away and killed.

M. Maxim, the inventor of the Maxim gun, is studying the construction of directable flying-machines, and believes that he has obtained a motor of sufficient force. M. Fontes Pereira de Mello believes that he is on the right road to the invention of a practical submarine boat.

The primitive monuments of the Balearic Islands are described by M. Cartailhac as of a Cyclopean or Pelasgic character, similar to those which are found throughout the Mediterranean region. Remains of real fortified towns, like a Greek acropolis, exist in Majorca and Minorca, usually at some distance from the most exposed coasts, sometimes on a plain and sometimes on an elevated spot. In the inside of each town there was a special monument of large hewn stones, so arranged as to form a semicircle. There were also galleries constructed by placing stones on pillars, under which one could hardly stand upright; and towers called *talayots*, the huge walls of which concealed small crypts or cellars. Human bones were found interred in artificial grottoes or crypts, to each of which entrance was gained by a small antechamber leading by a narrower portal.

The Illinois Experiment Station reports the results of comparative experiments at four stations—three of them in light-colored soils and the other in a darker soil—in raising wheat: on unmanured ground, on ground heavily treated with barn-yard manure, five wagon-loads to the quarter-acre, and on ground treated with one hundred pounds of superphosphate to the quarter-acre. The results showed decisively the superiority of the barn-yard manuring, while the beneficial effects of superphosphates on the amount of yield were relatively small.

One of the remarkable results of the spectroscopic observation of the great nebula of Orion by Mr. Keeler at Lick Observatory is the representation in them of the direction of the earth's orbital motion, so that the observer "would with some confidence undertake to determine the month of the year by measuring the distance of the principal line from the lead line used in the spectrum."

To estimate the relative merits of different kinds of points for lightning-conductors, Dr. Hess recently collected and examined nineteen heads of conductors that had been struck by lightning. His conclusions are that the fusion of points of lightning-conductors by lightning causes no danger of fire through scattering of fused drops, for this does not occur; that fine and smooth points receive the lightning-stroke in concentrated form, while sharply angled and ribbed and blunt points divide it into threads; that platinum needles and tips have no advantage over copper points; and that there are lightning-strokes which are capable of making incandescent brass wire 7·2 millimetres (say 0·29 inch) thick. Unbranched copper conductors should therefore never be thinner than 7 millimetres.

According to the observations of M. A. Muntz, the rain-water and the herbage of elevated regions are much poorer in sodium chloride than those of the lowlands, and the milk and the blood of animals feeding on the mountains contain a decidedly less proportion of the salt than are found in similar animals from the plains.

OBITUARY NOTES.

Mr. Charles Smith Wilson, Government Geologist of New South Wales, died August 26th, in his forty-eighth year. He was an original member of the Linnæan Society of New South Wales, and its president in 1883 and 1884.

Mr. William B. Watson, who died at Bolton, England, October 6th, in his eightieth year, was one of Dalton's last surviving pupils, and assisted him in his researches on the composition of the atmosphere, and was one of his nurses in his illness.

The Rev. Percy W. Myles, an English botanist and editor of Nature Notes, the journal of the Selborne Society, died October 7th, in his forty-third year. He was author of the Pronouncing Dictionary of Botanical Names appended to Nicholson's Dictionary of Gardening, which is recognized as a standard. As his circumstances were narrow, a Myles memorial fund is proposed to be raised for the benefit of his widow, for which Prof. George Henslow will receive contributions.

The death of Mr. Thomas Wharton Jones, F. R. S., one of Prof. Huxley's teachers forty years ago, is announced. He was nearly eighty years of age.

Dr. Philip Herbert Carpenter, fourth son of the late Dr. W. B. Carpenter, died at Eton College, England, October 21st, in his fortieth year, from the administration of chloroform during temporary insanity. He had been connected, in a scientific capacity, with expeditions of the Lightning and Porcupine, and with the Valorous of Sir G. Nares's Arctic Expedition. He made a specialty of the study of echinoderms, in which he became distinguished as an authority, and on which he published several papers and reports.

WILLIAM FERREL.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XV. ASTRONOMY.

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PART I.

THE next great series of battles was fought regarding the relations of the earth to the heavenly bodies. In the early Church, astronomy, like other branches of science, was very generally looked upon as futile, in view of the doctrine, so prominent in the New Testament, that the earth was in its last days. At best, the heavenly bodies were only objects of pious speculation. Some theologians, remembering the beautiful poetic vision of the morning stars singing together, revived an old theory that the heavenly lights have immortal souls. Tertullian's view of the solar system is seen in his theory that an eclipse of the sun was simply a sign of the wrath of God against unbelief. St. Augustine gave forth as final truth in sacred science a statement, based upon the Psalms, that "the heavens are like a curtain"; but his view of any scientific study is shown by his ejaculation, "What concern is it to me whether the heavens as a sphere inclose the earth in the middle of the world, or overhang it on either side?"

The prevailing view in the Church was based upon the declarations in Genesis that a solid vault—a "firmament"—was extended above the earth, and that the heavenly bodies were simply lights hung within it. This view plays a great part in the sacred theory established so firmly by the monk Cosmas in the sixth century. Having based his plan of the universe upon various texts in the Old and New Testaments, and having made it a vast oblong box, covered by the solid "firmament," he brings in an additional

view from Scripture to account for the planetary movements, and develops at length the theory that the sun and planets are moved and the "windows of heaven" opened and shut by angels appointed for that purpose.

How intensely real this way of looking at the universe was, we find in the writings of St. Isidore, the greatest leader of orthodox thought in the seventh century. He affirms that since the fall of man, and on account of it, the sun and moon shine with a feebler light; but he proves from a text in Isaiah that when the world shall be fully redeemed these "great lights" will shine again in all their early splendor.* But despite these authorities and their theological finalities, the evolution of scientific thought continued, its main germ being the geocentric doctrine—the doctrine that the earth is the center, and that the sun and planets revolve about it.

This doctrine was of the highest respectability: it had been developed at a very early period, and had been elaborated until it accounted well for the apparent movements of the heavenly bodies; its final name—"Ptolemaic theory"—carried weight; and, having thus come from antiquity into the Christian world, it was finally acquiesced in and universally held to agree with the letter and spirit of Scripture.†

Wrought into this foundation, and based upon it, there was developed in the middle ages, by means of Scriptural texts and theological reasonings, a new sacred system of astronomy, which became one of the great treasures of the universal Church—the last word of revelation.

Three great men mainly reared this structure. First was the unknown who gave to the world the treatises ascribed to Dionysius the Areopagite. It was unhesitatingly believed that these were the work of St. Paul's Athenian convert, and therefore virtually by St. Paul himself. Though now known to be spurious, they were then considered a treasure of inspiration, and an Em-

* For Tertullian's view of an eclipse of the sun, see the Ad Scapulam, cap. iii, in Migne, Patr. Lat., i, p. 701. For passage cited from Clement of Alexandria, see edition of T. Clark, Edinburgh, 1869, vol. ii, p. 368. For typical statements by St. Augustine, see De Genesi, ii, cap. ix, in Migne, Patr Lat., tome xxxiv, pp. 270, 271. For St. Isidore, see the De Ordine Creaturarum, cap. v, in Migne, Patr. Lat., lxxxiii, pp. 923–925; also, 1000, 1001. For Cosmas's view, see his Topographia Christiana in Montfauçon, Col. Nov. Patrum, ii, p. 150, and elsewhere as cited in my chapter on "Geography."

† As to the respectability of the geocentric theory, etc., see Grote's Plato, vol. iii, p. 257; also Sir G. C. Lewis's Astronomy of the Ancients, chap. iii, sec. 1, for a very thoughtful statement of Plato's view, and differing from ancient statements. For plausible elaboration of it, and for supposed agreement of Scripture with it, see Fromundus, Anti-Aristarchus, Antwerp, 1631; also Melanchthon's Initia Doctrinæ Physicæ. For an admirable statement of the theological view of the geocentric theory, antipodes, etc., see Eicken, *Geschichte der System der Mittelälterlichen Weltanschauung*, pp. 618 *et seq.*

peror of the East sent them to an Emperor of the West as the most worthy of gifts. In the ninth century they were widely made known in western Europe, and became a fruitful source of thought, especially on the whole celestial hierarchy; thus the old ideas of astronomy were vastly developed; and the heavenly hosts were classed and named in accordance with indications scattered through the sacred Scriptures.

The next of these three great theologians was Peter Lombard, professor at the University of Paris. About the middle of the twelfth century he gave forth his collection of "Sentences," or Statements by the Fathers, and this remained until the end of the middle ages the universal manual of theology. In it was especially developed the theological view of man's relation to the universe. The author tells the world: "Just as man is made for the sake of God—that is, that he may serve Him,—so the universe is made for the sake of man,—that is, that it may serve *him;* therefore is man placed at the middle point of the universe, that he may both serve and be served."

The vast significance of this view, and its power in resisting any real astronomical science, we shall see, especially in the time of Galileo.

The great triad of thinkers culminated in St. Thomas Aquinas, the sainted theologian, the glory of the mediæval Church, the "Angelic Doctor," the most marvelous intellect between Aristotle and Newton; he to whom it was believed that an image of the Crucified had spoken words praising his writings. Large of mind, strong, acute, yet just—even more than just—to his opponents, he gave forth, in the latter half of the thirteenth century, his Cyclopædia of Theology, the "Summa." In this he carried the sacred theory of the universe to its full development. With great power and clearness he brought the whole vast system, material and spiritual, into its relations to God and man.*

Such was the vast system developed by these three leaders of mediæval thought; and now came the man who wrought it yet more deeply into European belief, the poet divinely inspired who made the system part of the world's *life.* Under the touch of Dante the empyrean and the concentric heavens, paradise, purgatory, and hell, were seen of all men; the God Triune seated on his throne upon the circle of the heavens as real as the Pope seated

* For the contribution of the pseudo-Dionysius to mediæval cosmology see Dion., Areopagita, De Cælest. hierarch. vers. Joan. Scoti, in Migne, Patr. Lat., cxxii. For the contribution of Peter Lombard, see Pet. Lomb., Libr. Sent. II, i, 8; IV, i, 6, 7. For the citations from St. Thomas Aquinas, see the Summa, ed. Migne, especially Quæst. LXX, tome i, pp. 1174–1184; also Quæst. XLVII, Art. iii. For good general statement, see Milman, Latin Christianity, iv, 191 *et seq*; and for relation of Cosmas to these theologians of western Europe, see Milman, as above, viii, 228, note.

in the chair of St. Peter; the seraphim, cherubim, and thrones, surrounding the Almighty, as real as the cardinals surrounding the Pope; the three great orders of angels in heaven as real as the three great orders, bishops, priests, and deacons, on earth; and the whole system of spheres each revolving within the one above it and all moving about the earth, subject to the *primum mobile*, as real as the feudal system of western Europe, subject to the emperor.*

Let us look into this vast creation—the highest achievement of theology—somewhat more closely.

Its first feature shows an evolution: the earth is no longer the flat plain inclosed by four walls and solidly vaulted above, as theologians of previous centuries had believed it, under the inspiration of the monk Cosmas; it is no longer a mere flat disk with sun, moon, and stars hung up to give it light, as the earlier cathedral sculptors had figured it; it has become a globe at the center of the universe. Encompassing it are ten successive, transparent spheres, nine of them rotated by angels about the earth, and each carrying one of the heavenly bodies with it: that nearest the earth carrying the moon; the next, Mercury; the next, Venus; the next, the sun; the next three, Mars, Jupiter, and Saturn. The tenth heaven, inclosing all these, was the empyrean. This was immovable,—the boundary between creation and the great outer void; and here, in a light which no one can enter, the Triune God sat enthroned—the "music of the spheres" rising to him as they move.

In attendance upon the Divine Majesty, thus enthroned, are vast hosts of angels, and these are divided into three hierarchies, one serving in the empyrean, one in the heaven between the empyrean and the earth, and one on the earth.

Each of these hierarchies is divided into three choirs or orders; the first, into the orders of Seraphim, Cherubim, and Thrones; and the main occupation of these is to chant incessantly, to "continually cry" the divine praises.

The order of thrones conveys God's will to the second hierarchy—which serves in the movable heavens. This second hierarchy is also made up of three orders. The first of these, the

* For the central sun, hierarchy of angels, and concentric circles, see Dante, Paradiso, canto xxviii. For the words of St. Thomas Aquinas, showing to Virgil and Dante the great theologians of the middle ages, see canto x, and in Dean Plumptre's translation, vol. ii, pp. 56 *et seq.*; also Botta, Dante, pp. 350, 351. As to Dante's deep religious feeling and belief in his own divine mission, see J. R. Lowell, Among my Books, vol. i, p. 36. For a remarkable series of colored engravings showing Dante's whole cosmology, see La Materia della Divina Commedia di Dante dichiarata in vi tavole, da Michelangelo Caetani, published by the monks of Monte Cassino, to whose kindness the writer is indebted for his copy.

order of Dominions, receives the divine commands; the second, the order of Powers, moves the heavens, sun, moon, planets, and stars, opens and shuts the "windows of heaven," and brings to pass all other celestial phenomona; the third, the order of Empire, guards the others.

The third and lowest hierarchy is also made up of three orders. First of these are the Principalities—the guardian spirits of nations and kingdoms: next come Archangels; these protect religion, and bear the prayers of the saints to the foot of God's throne: finally, come Angels; these care for earthly affairs in general—one being appointed to each mortal, and others taking charge of the qualities of plants, metals, stones, and the like. Throughout the whole system, from the great Triune God to the lowest group of angels, we see at work the mystic power attached to the triangle and sacred number three—the same which gave the triune idea to ancient Hindoo theology, which developed the triune deities in Egypt, and which transmitted this theological gift to the Christian world, especially through the Egyptian monk Athanasius.

Below the earth is hell. This is tenanted by the angels who rebelled under the lead of Lucifer, prince of the seraphim—the former favorite of the Trinity; but of these rebellious angels, some still rove among the planetary spheres, and give trouble to the good angels; others pervade the atmosphere about the earth—carrying lightning, storm, drought, and hail. Others infest earthly society, tempting men to sin; but Peter Lombard and St. Thomas Aquinas take pains to show that the work of these devils is, after all, but to discipline man or to mete out deserved punishment.

All this vast scheme had been so knit into the Ptolemaic view and interwoven with it by the use of biblical texts and theological reasonings that the resultant system of the universe was considered impregnable and final. To attack it was blasphemy.

This system stood for centuries. Great theological scientists in following ages, like Vincent de Beauvais and Cardinal d'Ailly, devoted themselves to showing not only that it was supported by Scripture, but that it supported Scripture. Thus was the geocentric theory imbedded in the beliefs and aspirations, in the hopes and fears, of Christendom down to the middle of the sixteenth century.*

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* For the earlier sacred cosmology of Cosmas, with citations from Montfauçon, see my chapter on Geography. For the views of the mediæval theologians, see foregoing notes in this chapter. For the passages of Scripture on which the theological part of this structure was developed, see especially Romans viii, 38; Ephesians i, 21; Colossians i, 16, and ii, 15; and innumerable passages in the Old Testament. As to the music of the spheres, see Dean Plumptre's Dante, vol. ii, p. 4, note. For an admirable summing up of the mediæval

But, on the other hand, there had been planted, long before, the germs of the heliocentric theory. In the sixth century before our era, Pythagoras, and after him Philolaus, had suggested the movement of the earth and planets about a central fire; and three centuries later, Aristarchus had restated the main truth with striking precision. Here comes in a proof that the antagonism between theological and scientific methods is not confined to Christianity; for this statement brought upon Aristarchus the charge of blasphemy, and drew after it a cloud of prejudice which hid the truth for six hundred years:—not until the fifth century of our era does it timidly appear in the thoughts of Martianus Capella: then it is again lost to sight for a thousand years, until in the fifteenth century, distorted and imperfect, it appears in the writings of Cardinal Nicholas de Cusa.

But in the shade cast by the vast system which had grown from the mind of the great theologians and from the heart of the great poet there had come to this truth neither bloom nor fruitage.

Quietly, however, the soil was receiving enrichment and the air warmth. The processes of mathematics were constantly improved, the heavenly bodies were steadily observed, and at length appeared, far off from the centers of thought, on the borders of Poland, a plain, simple-minded scholar, who first fairly uttered to the modern world the truth—now so commonplace, then so astounding,—that the sun and planets do not revolve about the earth, but that the earth and planets revolve about the sun; and this man was Nicholas Copernicus.

Copernicus had been a professor at Rome, and even as early as 1500 had announced his doctrine there, but more in the way of a scientific curiosity or paradox, as it had been previously held by Cardinal de Cusa, than as the statement of a system representing a great fact in nature. About thirty years later one of his disciples, Widmanstadt, had explained it to Clement VII; but it still remained a mere hypothesis, and soon, like so many others, disappeared from the public view. But to Copernicus, steadily studying the subject, it became more and more a reality, and as the truth grew within him he seemed to feel that

cosmology in its relation to thought in general, see Rydberg, Magic of the Middle Ages, chapter i, whose admirable summary I have followed closely. For charts showing the continuance of this general view down to the beginning of the sixteenth century, see the various editions of the Margarita Philosophica, especially that of Strasburg, 1508, astronomical part. For interesting statements regarding the trinities of gods in ancient Egypt, see Sharpe, History of Egypt. The present writer once heard a lecture in Cairo, from an eminent Scotch Doctor of Medicine, to account for the ancient Hindoo and Egyptian sacred threes and trinities. The lecturer's theory was that when Jehovah came down into the garden of Eden and walked with Adam in "the cool of the day," he explained his triune character to Adam, and that from Adam it was spread abroad to the various ancient nations.

at Rome he was no longer safe. To announce his discovery there as a theory or a paradox might amuse the papal court, but to announce it as a truth—as *the* truth—was a far different matter. He therefore returned to his little town in Poland.

To publish his thought as it had now developed was evidently dangerous even there, and for more than thirty years it lay slumbering in the mind of Copernicus and of the friends to whom he had privately intrusted it.

At last he prepares his great work on the Revolutions of the Heavenly Bodies, and dedicates it to the Pope himself. He next seeks a place of publication: he dares not send it to Rome, for there are the rulers of the older Church ready to seize it; he dares not send it to Wittenberg, for there are the leaders of Protestantism no less hostile; it is therefore intrusted to Osiander, at Nuremberg.*

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* For germs of heliocentric theory planted long before, etc., see Sir G. C. Lewis; and for a succinct statement of the claims of Pythagoras, Philolaus, Aristarchus, and Martianus Capella, see Hoefer, Histoire de l'Astronomie, 1873, p. 107 *et seq.*; also, Heller, Geschichte der Physik, Stuttgart, 1882, vol. i, pp. 12, 13; also, pp. 99 *et seq.* For germs among thinkers of India, see Whewell, vol. i, p. 277; also, Whitney, Oriental and Linguistic Studies, New York, 1874; Essay on the Lunar Zodiac, p. 345. For the views of Vincent de Beauvais, see his Speculum Naturale, edition of 1480, lib. xvi, cap 21. For Cardinal d'Ailly's view, see his Ymago Mundi, 1490, treatise De Concordia Astronomicæ Veritatis cum Theologia.

For general statement of De Cusa's work, see Draper, Intellectual Development of Europe, p. 512. For skillful use of De Cusa's view in order to mitigate censure upon the Church for its treatment of Copernicus's discovery, see an article in the Catholic World for January, 1869. For a very exact statement, in a spirit of judicial fairness, see Whewell, History of the Inductive Sciences, p. 275 and pp. 379, 380. In the latter, Whewell cites the exact words of De Cusa in the De Docta Ignorantia, and sums up in these words: "This train of thought might be a preparation for the reception of the Copernican system; but it is very different from the doctrine that the sun is the center of the planetary system." Whewell says: "De Cusa propounded the doctrine of the motion of the earth more as a paradox than a reality. We can not consider this as any distinct anticipation of a profound and consistent view of the truth." On De Cusa, see also Heller, vol. i, p. 216. For Aristotle's views, and their elaboration by St. Thomas Aquinas, see the De Cœlo et Mundo, sec. xx, and elsewhere in the latter. It is curious to see how even such a biographer as Archbishop Vaughan slurs over the angelic doctor's errors. See Vaughan's Life and Labors of St. Thomas of Aquin, pp. 459, 460.

Copernicus's Danger at Rome.—The Catholic World for January, 1869, cites a speech of the Archbishop of Mechlin, before the University of Louvain, to the effect that Copernicus defended his theory at Rome, in 1500, before two thousand scholars; also, that another professor taught the system in 1528, and was made apostolic notary by Clement VIII. All this, even if the doctrines taught were identical with those of Copernicus, as finally developed, which is simply not the case, avails nothing against the overwhelming testimony that Copernicus felt himself in danger—testimony which the after-history of the Copernican theory renders invincible. The very title of Fromundus's book, already cited, published within a few miles of the archbishop's own cathedral, and sanctioned expressly by the theological faculty of that same University of Louvain in 1630, utterly refutes the archbishop's idea that the Church was inclined to treat Copernicus kindly.

But Osiander's courage fails him: he dares not launch the new thought boldly. He writes a groveling preface, endeavoring to excuse Copernicus for his novel idea, and in this he inserts the apologetic lie that Copernicus propounds the doctrine of the earth's movement not as a fact, but as a hypothesis; he declares that it is lawful for an astronomer to indulge his imagination, and that this is what Copernicus has done.

Thus was the greatest and most ennobling, perhaps, of scientific truths—a truth not less ennobling to religion than to science—forced in coming before the world to sneak and crawl.*

On the 24th of May, 1543, the newly printed book arrived at the house of Copernicus. It was put into his hands; but he was on his death-bed. A few hours later he was beyond the reach of the conscientious men who would have blotted his reputation, and perhaps have destroyed his life.

Yet not wholly beyond their reach. Even death could not be trusted to shield him. There seems to have been fear of vengeance upon his corpse, for on his tombstone was placed no record of his life-long labors, no mention of his great discovery; but there was graven upon it simply a prayer: "I ask not the grace accorded to Paul; not that given to Peter; give me only the favor

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The title is as follows: "Anti-Aristarchus sive Orbis-Terræ Immobilis in quo decretum S. Congregationis S. R. E. Cardinalium I.ↄC.XVI adversus Pythagorico-Copernicanos editum defenditur, Antwerpiæ, MDCXXXI." L'Epinois, Galilée, Paris, 1867, lays stress, p. 14, on the broaching of the doctrine by De Cusa, in 1435, and by Widmanstadt in 1533, and their kind treatment by Eugenius IV and Clement VII, but this is absolutely worthless in denying the papal policy afterward. Lange, Geschichte des Materialismus, vol. i, pp. 217, 218, while admitting that De Cusa and Widmanstadt sustained this theory, and received honors from their respective popes, shows that, when the Church gave it serious consideration, it was condemned. There is nothing in this view unreasonable. It would be a parallel case to that of Leo X, at first inclined toward Luther and others, in their "squabbles with the begging friars," and afterward forced to oppose them. That Copernicus felt the danger is evident, among other things, by the expression in the preface: "*Statim me explodendum cum tali opinione clamitant.*" For dangers at Wittenberg, see Lange, Geschichte des Materialismus, vol. i, p. 217.

* Osiander, in a letter to Copernicus, dated April 20, 1541, had endeavored to reconcile him to such a procedure, and ends by saying, "Sic enim placidiores reddideris peripatheticos et theologos quos contradicturos metuis." See Apologia Tychonis in Kepleri Opera Omnia, Frisch's edition, vol. i, p. 246. Kepler holds Osiander entirely responsible for this preface. Bertrand, in his Fondateurs de l'Astronomie moderne, gives its text, and thinks it possible that Copernicus may have yielded "in pure condescension toward his disciple." But this idea is utterly at variance with expressions in Copernicus's own dedicatory letter to the Pope, which follows the preface. For a good summary of the argument, see Figuier, Savants de la Renaissance, pp. 378, 379; see, also, citation from Gassendi's Life of Copernicus, in Flammarion, Vie de Copernic, p. 124. Mr. John Fiske, accurate as he usually is, in his Outlines of Cosmic Philosophy, appears to have followed Laplace, Delambre, and Petit into the error of supposing that Copernicus, and not Osiander, is responsible for the preface. For the latest proofs, see Menzer's translation of Copernicus's work, Thorn, 1879, notes on pp. 3 and 4 of the appendix.

which Thou didst show to the thief on the cross." Not till thirty years after did a friend dare write on his tombstone a memorial of his discovery.*

The preface of Osiander, pretending that the book of Copernicus suggested a hypothesis instead of announcing a truth, served its purpose well as regards the book itself. During nearly seventy years the Church authorities evidently thought it best not to stir the matter, and in some cases professors like Calganini were allowed to present the new view purely as a hypothesis. There were, indeed, mutterings from time to time on the theological side, but there was no great demonstration against the system until 1616. Then, when the Copernican doctrine was upheld by Galileo as a *truth*, and proved to be a truth by his telescope, the book was taken in hand by the Roman curia. The statements of Copernicus were condemned "until they should be corrected," and the corrections required were simply such as would substitute for his conclusions the old Ptolemaic theory.

That this was their purpose was seen in that year when Galileo was forbidden to teach or discuss the Copernican theory, and when were forbidden "all books which affirm the motion of the earth." Henceforth to read the work of Copernicus was to risk damnation, and the world accepted the decree.†

There was, indeed, in Europe one man who might have done much to check this current of unreason which was to sweep away so many thoughtful men on the one hand from scientific knowledge, and so many on the other from Christianity. This

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* See Figuier, Savants de la Renaissance, p. 380; also, Flammarion, Vie de Copernic, p. 190.

† The authorities deciding this matter in accordance with the wishes of Pope Paul V and Cardinal Bellarmine were the Congregation of the Index, or cardinals having charge of the Index Librorum Prohibitorum. Recent desperate attempts to fasten the responsibility on them as individuals seem ridiculous in view of the simple fact that their work was sanctioned by the highest Church authority, and required to be universally accepted by the Church. Eleven different editions of the Index in my own possession prove this. Nearly all of these declare on their title-pages that they are issued by order of the pontiff of the period, and each is prefaced by a special papal bull or letter. See especially the Index of 1664, issued under order of Alexander VII, and that of 1761, under Benedict XIV. Copernicus's statements were prohibited in the Index "*donec corrigantur*." Kepler said that it ought to be worded "*donec explicetur*." See Bertrand, Fondateurs de l'Astronomie moderne, page 57. De Morgan, pages 57–60, gives the corrections required by the Index of 1620. Their main aim seems to be to reduce Copernicus to the groveling level of Osiander, making of his discovery a mere hypothesis; but occasionally they require a virtual giving up of the whole Copernican doctrine—e. g., "correction" insisted upon for chapter viii, p. 6. For a scholarly account of the relation of the Prohibitory and Expurgatory Indexes to each other, see Mendham, Literary Policy of the Church of Rome; also, Reusch, Index der verbotenen Bücher, Bonn, 1855, vol. ii, chaps. i and ii. For a brief but very careful statement, see Gebler, Galileo Galilei, English translation, London, 1879, chap. i; see, also, Addis and Arnold's Catholic Dictionary, article Galileo, p. 8.

was Peter Apian. He was one of the great mathematical and astronomical scholars of the time. His brilliant abilities had made him the astronomical teacher of the Emperor Charles V; his work on geography had brought him a world-wide reputation; his work on astronomy brought him a patent of nobility; his improvements in mathematical processes and astronomical instruments brought him the praise of Kepler and a place in the history of science: never had a true man a better opportunity to do a great deed. When Copernicus's work appeared, Apian was at the height of his reputation and power: a quiet, earnest plea from him, even if it had been only for ordinary fairness and a suspension of judgment, must have carried much weight. His devoted pupil, Charles V, who sat on the thrones of Germany and Spain, must at least have given a hearing to such a plea. But, unfortunately, Apian was a professor in an institution of learning under the strictest Church control—the University of Ingolstadt. His foremost duty was to teach *safe* science—to keep science within the line of scriptural truth as interpreted by theological professors. His great opportunity was lost. Apian continued to maunder over the Ptolemaic theory and astrology in his lecture-room. As to the attacks on the Copernican theory, he neither supported nor opposed them; he was silent; and the cause of his silence should never be forgotten so long as any church asserts its title to control university instruction.*

Doubtless, many will exclaim against the Roman Catholic Church for this; but the simple truth is that Protestantism was no less zealous against the new scientific doctrine. All branches of the Protestant Church—Lutheran, Calvinist, Anglican—vied with each other in denouncing the Copernican doctrine as contrary to Scripture; and, at a later period, the Puritans showed the same tendency.

Said Martin Luther: "People gave ear to an upstart astrologer who strove to show that the earth revolves, not the heavens or the firmament, the sun and the moon. Whoever wishes to appear clever must devise some new system, which of all systems is of course the very best. This fool wishes to reverse the entire science of astronomy; but sacred Scripture tells us that Joshua commanded the sun to stand still and not the earth." Melanchthon, mild as he was, was not behind Luther in condemning Copernicus. In his treatise on the Elements of Physics, published six years after Copernicus's death, he says: "The eyes are witnesses that the heavens revolve in the space of twenty-four

* For Peter Apian, see Mädler, Geschichte der Astronomie, Braunschweig, 1873, vol. i, p. 141. For evidences of the special favor of Charles V, see Delambre, Histoire de l'Astronomie du Moyen Age, p. 390; also Brühns, in the Allgemeine deutsche Biographie. For an attempted apology for him, see Günther, Peter and Philipp Apian, Prag, 1882, p. 62.

hours. But certain men, either from the love of novelty, or to make a display of ingenuity, have concluded that the earth moves; and they maintain that neither the eighth sphere nor the sun revolves. . . . Now, it is a want of honesty and decency to assert such notions publicly, and the example is pernicious. It is the part of a good mind to accept the truth as revealed by God and to acquiesce in it." Melanchthon then cites passages from the Psalms and from Ecclesiastes, which he declares assert positively and clearly that the earth stands fast, and that the sun moves around it, and adds eight other proofs of his proposition that "the earth can be nowhere if not in the center of the universe." So earnest does this mildest of the Reformers become, that he suggests severe measures to restrain such impious teachings as those of Copernicus.*

While Lutheranism was thus condemning the theory of the earth's movement, other branches of the Protestant Church did not remain behind. Calvin himself took the lead, in his Commentary on Genesis, by condemning all who asserted that the earth is not at the center of the universe. "Who," he said, "will venture to place the authority of Copernicus above that of the Holy Spirit?" Turretin, Calvin's famous successor, even after Kepler and Newton had virtually completed the theory of Copernicus and Galileo, put forth his compendium of theology, in which he proved, from a multitude of scriptural texts, that the heavens, sun, and moon move about the earth, which stands still in the center. In England we see similar theological efforts, even after they had become evidently hopeless. Hutchison's Moses' Principia, Dr. Samuel Pikes's Sacred Philosophy, the writings of Bishop Horne, Bishop Horsely, and President Forbes contain most earnest attacks upon the ideas of Newton; such attacks being based upon Scripture. Dr. John Owen, so famous in the annals of Puritanism, declared the Copernican system a "delusive and arbitrary hypothesis, contrary to Scripture"; and even John Wesley declared the new ideas to tend toward "infidelity." †

And Protestant peoples were not a whit behind Catholic in following out such teachings. The people of Elbing made them-

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* See the Walsch edition of Luther's works, 1743, p. 2260; also the Tischreden; also Melanchthon's Initia Doctrinæ Physicæ. This treatise is cited under a mistaken title by the Catholic World, September, 1870. The correct title is as given above; it will be found in the Corpus Reformatorum, ed. Bretschneider, Halle, 1846. (For the above passage see vol. xiii, pp. 216, 217; also, Mädler, vol. i, p. 176; also, Lange, Geschichte des Materialismus, vol. i, p. 217; also, Prowe, Ueber die Abhängigkeit des Copernicus, Thorn, 1865, p. 4; also note, pp. 5, 6, where text is given in full.)

† On the Teachings of Protestantism as regards the Copernican theory, see citations in Canon Farrar's History of Interpretation, preface, xviii; also, Rev. Dr. Shields, of Princeton, The Final Philosophy, pp. 60, 61.

selves merry over a farce in which Copernicus was the main object of ridicule. The people of Nuremberg, a Protestant stronghold, caused a medal to be struck with inscriptions ridiculing the philosopher and his theory.

Why the people at large took this view is easily understood when we note the attitude of the guardians of learning, both Catholic and Protestant, in that age. It throws great light upon sundry claims by modern theologians to take charge of public instruction and of the evolution of science. So important was it thought to have "sound learning" guarded, and "safe science" taught, that in many of the universities, as late as the end of the seventeenth century, professors were forced to take an oath not to hold the "Pythagorean"—that is, the Copernican idea—as to the movement of the heavenly bodies. As the contest went on, professors were forbidden to make known to students the facts revealed by the telescope. Special orders to this effect were issued by the ecclesiastical authorities to the universities and colleges of Pisa, Innspruck, Louvain, Douay, Salamanca, and others; during generations we find the authorities of these universities boasting that these godless doctrines were kept away from their students. It is touching to hear such boasts made then, just as it is touching now to hear sundry excellent university authorities boast that they discourage the reading of Mill, Spencer, and Darwin. Nor were such attempts to keep the truth from students confined to the Roman Catholic institutions of learning. Strange as it may seem, nowhere were the facts confirming the Copernican theory more carefully kept out of sight than at Wittenberg; the university of Luther and Melanchthon. About the middle of the sixteenth century there were at that center of Protestant instruction two astronomers of a very high order, Rheticus and Reinhold: both of these, after thorough study, had convinced themselves that the Copernican system was true, but neither of them was allowed to tell this truth to his students. Neither in his lecture announcements nor in his published works did Rheticus venture to make the new system known, and he at last gave up his professorship and left Wittenberg, that he might have freedom to seek and tell the truth. Reinhold was even more wretchedly humiliated. Convinced of the truth of the new theory, he was obliged to advocate the old; if he mentioned the Copernican ideas, he was compelled to overlay them with the Ptolemaic. Even this was not thought safe enough, and in 1571 the subject was intrusted to Peucer. He was eminently "sound," and denounced the Copernican theory in his lectures as "absurd and unfit to be introduced into the schools."

To clinch anti-scientific ideas more firmly into German Protestant teaching, Rector Hensel wrote a text-book for schools en-

titled "The Restored Mosaic System of the World," which showed the Copernican astronomy to be unscriptural.

Doubtless this has a far-off sound; yet its echo comes very near modern Protestantism in the expulsion of Dr. Woodrow by the Presbyterian authorities in South Carolina; the expulsion of Prof. Winchell by the Methodist Episcopal authorities of Tennsesee; the expulsion of Prof. Toy by the authorities of another Protestant sect in Kentucky; the expulsion of the professors at Beyrout under authority of the American Board of Commissioners for Foreign Missions—all for holding the doctrines of modern science, and in the last years of the nineteenth century.

When Protestants talk of the "bigotry" of the Roman Catholic Church, they will do well to remember that it is impossible to imagine such Catholic authorities as Cardinal Gibbons, Archbishops Ireland and Kenrick, and Bishops Keane and Spalding, sanctioning such suicidal folly as this. The Mother Church has learned something.*

But the new truth could not be concealed; it could neither be laughed down nor frowned down. Many minds had received it, but within the hearing of the papacy only one tongue appears to have dared to utter it clearly. This new warrior was that strange mortal, Giordano Bruno. He was hunted from land to land, until at last he turned on his pursuers with fearful invectives. For this he was imprisoned during six years, then burned alive, and his ashes scattered to the winds.† Still, the new truth lived on. Ten years after the martydom of Bruno the truth of Copernicus's doctrine was established by the telescope of Galileo.

Herein was fulfilled one of the most touching of prophecies. Years before, the opponents of Copernicus had said to him, "If your doctrines were true, Venus would show phases like the moon." Copernicus answered: "You are right; I know not what to say; but God is good, and will in time find an answer to this objection." The God-given answer came when in 1611 the rude telescope of Galileo showed the phases of Venus.‡

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* For treatment of Copernican ideas by the people, see The Catholic World, as above; also, Melanchthon, *ubi supra*; also, Prowe, Copernicus, Berlin, 1883, vol. i, p. 269, note; also, pp. 279, 280; also Mädler, i, p. 167. For Rector Hensel, see Rev. Dr. Shield's Final Philosophy, p. 60. For details of recent Protestant efforts against evolution doctrines, see my chapter on The Fall of Man and Anthropology, in this series.

† For Bruno, see Bartholmess, Vie de Jordano Bruno, Paris, 1846, vol. i, p. 121 and pp. 212 *et seq.*; also Berti, Vita di Giordano Bruno, Firenze, 1868, chapter xvi; also Whewell, vol. i, pp. 272, 273. That Whewell is somewhat hasty in attributing Bruno's punishment entirely to the Spaccio della Bestia Trionfante will be evident, in spite of Montucla, to any one who reads the account of the persecution in Bartholmess or Berti; and, even if Whewell be right, the Spaccio would never have been written but for Bruno's indignation at ecclesiastical oppression. See Tiraboschi, vol. vii, pp. 466 *et seq.*

‡ For the relation of these discoveries to Copernicus's work, see Delambre, Histoire de

On this new champion, Galileo, the whole war was at last concentrated. His discoveries had clearly taken the Copernican theory out of the list of hypotheses, and had placed it before the world as a truth. Against him, then, the war was long and bitter. The supporters of what was called "sound learning" declared his discoveries deceptions and his announcements blasphemy. Semi-scientific professors, endeavoring to curry favor with the Church, attacked him with sham science; earnest preachers attacked him with perverted Scripture; theologians, inquisitors, congregations of cardinals, and at last two popes dealt with him, and, as was supposed, silenced his impious doctrine forever.*

I shall present this warfare at some length because, so far as I can find, no careful summary of it has been given in our language, since the whole history was placed in a new light by the revelations of the trial documents in the Vatican Library, honestly published for the first time by M. L'Epinois, in 1867, and since that by Gebler, Berti, Favaro, and others.

The first important attack on Galileo began in 1610, when he announced that his telescope had revealed the moons of the planet Jupiter. The enemy saw that this took the Copernican theory out of the realm of hypothesis, and they gave battle immediately. They denounced both his method and its results as absurd and impious. As to his method, professors bred in the "safe science" favored by the Church argued that the only way of studying the universe was by comparing texts of Scripture; and, as to his results, they insisted, first, that Aristotle knew nothing of these new revelations; and, next, that the Bible showed by all applicable types that there could be only seven planets; that this was proven by the seven golden candlesticks of the Apocalypse, by the seven-branched candlestick of the tabernacle, and by the seven churches of Asia; that from Galileo's doctrine consequences must logically result destructive to Christian truth: bishops and priests therefore warned their flocks, and multitudes of the faithful besought the Inquisition to deal speedily and sharply with the heretic.†

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l'Astronomie Moderne, discours préliminaire, p. xiv; also Laplace, Système du Monde, vol. i, p. 326; and for more careful statements, Kepleri Opera Omni, edit. Frisch., tome ii, p. 464. For Copernicus's prophecy, see Cantu, Histoire Universelle, vol. xv, p. 473 (Cantu is an eminent Roman Catholic).

* A very curious example of this sham science employed by theologians is seen in the argument, frequently used at that time, that, if the earth really moved, a stone falling from a height would fall back of the point immediately below its point of starting. This is used by Fromundus with great effect. It appears never to have occurred to him to test the matter by dropping a stone from the topmast of a ship; Benzenburg has experimentally demonstrated just such an aberration in falling bodies as is mathematically required by the diurnal motion of the earth. See Jevons, Principles of Science, pp. 388, 389, in one volume, second edition, 1877.

† See Delambre on the discovery of the satellites of Jupiter as the turning-point with

In vain did Galileo try to prove the existence of satellites by showing them to the doubters through his telescope: they either declared it impious to look, or, if they did look, denounced the satellites as illusions from the devil. Good Father Clavius declared that "to see satellites of Jupiter, men had to make an instrument which would create them." In vain did Galileo try to save the great truths he had discovered by his letters to the Benedictine Castelli and the Grand Duchess Christine, in which he argued that literal biblical interpretation should not be applied to science; it was answered that such an argument only made his heresy more detestable; that he was "worse than Luther or Calvin."

The war on the Copernican theory, which up to that time had been carried on quietly, now flamed forth. It was declared that the doctrine was proved false by the standing still of the sun for Joshua, by the declarations that "the foundations of the earth are fixed so firm that they can not be moved," and that the sun "runneth about from one end of the heavens to the other." *

But the little telescope of Galileo still swept the heavens, and another revelation was announced—the mountains and valleys in the moon. This brought on another attack. It was declared that this, and the statement that the moon shines by light reflected from the sun, directly contradict the statement in Genesis that the moon is "a great light." To make the matter worse, a painter, placing the moon in a religious picture in its usual position beneath the feet of the Blessed Virgin, outlined on its surface mountains and valleys; this was denounced as a sacrilege logically resulting from the astronomer's heresy.

Still another struggle was aroused when the hated telescope revealed spots upon the sun, and their motion indicating the sun's rotation. Monsignor Elci, head of the University of Pisa, forbade the astronomer Castelli to mention these spots to his students. Father Busaeus, at the University of Innspruck, forbade

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the heliocentric doctrine. As to its effects on Bacon, see Jevons, Principles of Science, p. 638, as above. For argument drawn from the candlestick and seven churches, see Delambre, p. 20.

* For principal points as given, see Libri, Histoire des Sciences mathématiques en Italie, vol. iv, p. 211; De Morgan, Paradoxes, p. 26, for account of Father Clavius. It is interesting to know that Clavius, in his last years, acknowledged that "the whole system of the heavens is broken down, and must be mended." Cantu, Histoire Universelle, vol. xv, p. 478. See Th. Martin, Galilée, pp. 34, 208, and 266; also Heller, Geschichte der Physik, Stuttgart, 1882, vol. i, p. 366. For the original documents, see L'Epinois, pp. 34 and 36. Martin's translation seems somewhat too free. See also, Gebler, Galileo Galilei, English translation, London, 1879, pp. 76–78; also Gebler, Acten des Galileischen Process, for careful copies of the documents; also Reusch, Der Process Galilei's und die Jesuiten, Bonn, 1879, chapters ix, x, xi. See also full official text in L'Epinois, and also the extract given by Gebler, Galileo Galilei, p. 78.

the astronomer Scheiner, who had also discovered the spots and proposed a *safe* explanation of them, to allow the new discovery to be known there. At the College of Douay and the University of Louvain this discovery was expressly placed under the ban, and this became the general rule among the Catholic universities and colleges of Europe. The Spanish universities were especially intolerant of this and similar ideas, and up to a recent period they were strictly forbidden in the most important university of all—that of Salamanca.*

Such are the consequences of placing the instruction of men's minds in the hands of those mainly absorbed in saving men's souls. Nothing could be more in accordance with the idea recently put forth by sundry ecclesiastics, Catholic and Protestant, that the Church alone is empowered to promulgate scientific truth or direct university instruction. But science gained the victory here also. Observations of the solar spots were reported not only from Galileo, in Italy, but from Fabricius, in Holland. Father Scheiner then endeavored to make the usual compromise between theology and science. He promulgated a pseudo-scientific theory, which only provoked derision.

The war became more and more bitter. The Dominican father, Caccini, preached a sermon from the text, "Ye men of Galilee, why stand ye gazing up into heaven?" and this wretched pun upon the great astronomer's name ushered in sharper weapons; for, before Caccini ends, he insists that "geometry is of the devil," and that "mathematicians should be banished as the authors of all heresies." The church authorities gave Caccini promotion.

Father Lorini proved that Galileo's doctrine was not only heretical but "atheistic," and besought the Inquisition to intervene. The Bishop of Fiesole screamed in rage against the Copernican system, publicly insulted Galileo, and denounced him to the grand duke. The Archbishop of Pisa secretly sought to entrap Galileo and deliver him to the Inquisition at Rome. The Archbishop of Florence solemnly condemned the new doctrines as unscriptural; and Paul V, while petting Galileo, and inviting him as the greatest astronomer of the world to visit Rome, was secretly moving the Archbishop of Pisa to pick up evidence against the astronomer.

But by far the most terrible champion who appeared against the new astronomy was Cardinal Bellarmin, one of the greatest theologians the world has known. He was earnest, sincere, and learned, but insisted on making science conform to Scripture. The weapons which men of Bellarmin's stamp used were purely theological. They held up before the world the dreadful conse-

* See Ticknor, History of Spanish Literature, vol. iii.

quences which must result to Christian theology were the heavenly bodies proved to revolve about the sun and not about the earth. Their most tremendous engine against Galileo was the statement that "his pretended discovery vitiates the whole Christian plan of salvation." Father Lecazre declared that "it casts suspicion on the doctrine of the incarnation." Others declared that it "upsets the whole basis of theology; that if the earth is a planet, and only one among several planets, it can not be that any such great things have been done specially for it as the Christian doctrine teaches. If there are other planets, since God makes nothing in vain, they must be inhabited; but how can these inhabitants be descended from Adam? How can they trace back their origin to Noah's ark? How can they have been redeemed by the Saviour?" Nor was this argument confined to the theologians of the Roman Church; Melanchthon, Protestant as he was, had already used it in his attacks on Copernicus and his school.

In addition to this prodigious theological engine of war there was kept up a fire of smaller artillery in the shape of texts and scriptural extracts.

But the war grew still more bitter, and some weapons used in it are worth examining. They are very easily examined, for they are to be found on all the battle-fields of science; but on that field they were used with more effect than on almost any other. These weapons are the epithets "infidel" and "atheist." The battle-fields of science are thickly strewn with these. They have been used against almost every man who has ever done anything new for his fellow-men. The list of those who have been denounced as "infidel" and "atheist" includes almost all great men of science, general scholars, inventors, and philanthropists. The purest Christian life, the noblest Christian character, have not availed to shield combatants. Christians like Isaac Newton, Pascal, Locke, Milton, and even Fénelon and Howard, have had this weapon hurled against them. Of all proofs of the existence of a God, those of Descartes have been wrought most thoroughly into the minds of modern men; yet the Protestant theologians of Holland sought to bring him to torture and to death by the charge of atheism, and the Roman Catholic theologians of France prevented any due honors to him at his burial.*

These epithets can hardly be classed with civilized weapons. They are burning arrows; they set fire to masses of popular prejudice, always obscuring the real question, sometimes destroy-

* For various objectors and objections to Galileo by his contemporaries, see Libri, Histoire des Sciences mathématiques en Italie, vol. iv, pp. 233, 234; also Martin, Vie de Galilée. For Father Lecazre's argument, see Flammarion, Mondes imaginaires et réels, 6ième édition, pp. 315, 316. For Melanchthon's argument, see his Initia, in Opera, vol. iii, Halle, 1846.

ing the attacking party. They are poisoned weapons. They pierce the hearts of loving women; they alienate dear children; they injure man after life is ended, for they leave poisoned wounds in the hearts of those who loved him best—fears for his eternal salvation, dread of the divine wrath upon him. Of course, in these days these weapons, though often effective in vexing good men and in scaring good women, are somewhat blunted; indeed, they not infrequently injure the assailants more than the assailed. So it was not in the days of Galileo; they were then in all their sharpness and venom.* Yet worse even than these weapons was the attack by the Archbishop of Pisa.

This man, whose cathedral derives its most enduring fame from Galileo's deduction of a great natural law from the swinging lamp before its altar, was not an archbishop after the noble mold of Borromeo and Fénelon and Cheverus. He was, sadly enough for the Church and humanity, simply a zealot and intriguer: he perfected the plan for entrapping the great astronomer.

Galileo, after his discoveries had been denounced, had written to his friend Castelli and to the Grand Duchess Christine two letters to show that his discoveries might be reconciled to Scripture. On a hint from the Inquisition at Rome, the archbishop sought to get hold of these letters and exhibit them as proofs that Galileo had uttered heretical views of theology and of Scripture, and thus to bring him into the clutch of the Inquisition. The archbishop begs Castelli, therefore, to let him see the original letter in the handwriting of Galileo. Castelli declines; the archbishop then, while, as is now revealed, writing constantly and bitterly to the Inquisition against Galileo, professes to Castelli the greatest admiration of Galileo's genius and a sincere desire to know more of his discoveries. This not succeeding, the archbishop at last throws off the mask and resorts to open attack.

The whole struggle to crush Galileo and to save him would be amusing were it not so fraught with evil. There were intrigues and counter-intrigues, plots and counter-plots, lying and spying; and, in the thickest of this seething, squabbling, screaming mass of priests, bishops, archbishops, and cardinals, strove two popes, Paul V and Urban VIII. It is most suggestive to see in this crisis of the Church, at the tomb of the prince of the apostles, on the eve of the greatest errors in church policy the world has known, in all the intrigues and deliberations of these consecrated

* For curious exemplification of the way in which these weapons have been hurled, see lists of persons charged with "infidelity" and "atheism," in Le Dictionnaire des Athées, Paris, An. viii; also Lecky, History of Rationalism, vol. ii, p. 50. For the case of Descartes, see Saisset, Descartes et ses Précurseurs, pp. 103, 110.

leaders of the Church, no more evidence of the guidance or presence of the Holy Spirit than in a caucus of New York politicians at Tammany Hall.

But the opposing powers were too strong: in 1615 Galileo was summoned before the Inquisition at Rome, and the mine which had been so long preparing was sprung. Sundry theologians of the Inquisition having been ordered to examine two propositions which had been extracted from Galileo's letters on the solar spots, solemnly considered these points during about a month and rendered their unanimous decision as follows: "*The first proposition, that the sun is the center and does not revolve about the earth, is foolish, absurd, false in theology, and heretical, because expressly contrary to Holy Scriptures*"; and "*the second proposition, that the earth is not the center but revolves about the sun, is absurd, false in philosophy, and, from a theological point of view at least, opposed to the true faith.*"

The Pope himself, Paul V, now intervened again: he ordered that Galileo be brought before the Inquisition. Then the greatest man of science in that age was brought face to face with the greatest theologian—Galileo was confronted by Bellarmin. Bellarmin shows Galileo the error of his opinion and orders him to renounce it. De Lauda, fortified by a letter from the Pope, gives orders that the astronomer be placed in the dungeons of the Inquisition should he refuse to yield. Bellarmin now commands Galileo, "in the name of his Holiness the Pope and the whole Congregation of the Holy Office, to relinquish altogether the opinion that the sun is the center of the world and immovable, and that the earth moves, nor henceforth to hold, teach, or defend it in any way whatsoever, verbally or in writing." This injunction Galileo acquiesces in and promises to obey.*

This was on the 26th of February, 1616. About a fortnight later the Congregation of the Index, moved thereto, as the letters and documents now brought to light show, by Pope Paul V, solemnly rendered a decree that "*the doctrine of the double motion of the earth about its axis and about the sun* is false and entirely contrary to *Holy Scripture*"; and that this opinion must neither be taught nor advocated. The same decree condemned all writings of Copernicus and "*all writings which affirm the motion of the earth.*" The great work of Copernicus was interdicted until corrected in accordance with the views of the Inquisition; and the works of Galileo and Kepler, though not mentioned by name at

* I am aware that the theory proposed by Wohlwill and developed by Gebler denies that this injunction and promise were ever made by Galileo, and holds that the passage was a forgery devised later by the Church rulers to justify the proceedings of 1632 and 1633. This would make the conduct of the Church worse, but the better authorities consider the charge not proved. A careful examination of the documents seems to disprove it.

that time, were included among those implicitly condemned as "affirming the motion of the earth."

The condemnations were inscribed upon the Index; and, finally, the papacy committed itself as a judge and teacher to the world by prefixing to the Index the usual papal bull giving its monitions the most solemn papal sanction. To teach or even read the works denounced or passages condemned was to risk persecution in this world and damnation in the next. Science had apparently lost the decisive battle.

For a time after this judgment Galileo remained in Rome, apparently hoping to find some way out of this difficulty; but he soon discovered the hollowness of the protestations made to him by ecclesiastics, and, being recalled to Florence, remained in his hermitage near the city in silence, working steadily, indeed, but not publishing anything save by private letters to friends in various parts of Europe.

But at last a better vista seemed to open before him. Cardinal Barberini, who had seemed liberal and friendly, became pope under the name of Urban VIII. Galileo at this conceived new hopes, and allowed his continued allegiance to the Copernican system to be known. New troubles ensued. Galileo was induced to visit Rome again, and Pope Urban tried to cajole him into silence, personally taking the trouble to show him his errors by argument. Other opponents were less considerate, for works appeared attacking his ideas—works all the more unmanly, since their authors knew that Galileo was restrained by force from defending himself. Then, too, as if to accumulate proofs of the unfitness of the Church to take charge of advanced instruction, his salary as a professor at the University of Pisa was taken from him, and sapping and mining began. Just as the Archbishop of Pisa some years before had tried to betray him with honeyed words to the Inquisition, so now Father Grassi tried it, and, after various attempts to draw him out by flattery, suddenly denounced his scientific ideas as "leading to a denial of the real presence in the eucharist."

For the final assault upon him a park of heavy artillery was at last wheeled into place. It may be seen on all the scientific battle-fields. It consists of general denunciation; and in 1631 Father Melchior Inchofer, of the Jesuits, brought his artillery to bear upon Galileo with this declaration: "The opinion of the earth's motion is of all heresies the most abominable, the most pernicious, the most scandalous; the immovability of the earth is thrice sacred; argument against the immortality of the soul, the existence of God, and the incarnation, should be tolerated sooner than an argument to prove that the earth moves."

From the other end of Europe came a powerful echo. From

the shadow of the Cathedral of Antwerp, the noted theologian, Fromundus, gave forth his famous treatise, the Anti-Aristarchus. Its very title-page was a contemptuous insult to the memory of Copernicus, since it paraded the assumption that the new truth was only an exploded theory of a pagan astronomer. Fromundus declares that "sacred Scripture fights against the Copernicans." To prove that the sun revolves about the earth he cites the passage in the Psalms which speaks of the sun "which cometh forth as a bridegroom out of his chamber." To prove that the earth stands still, he quotes a passage from Ecclesiastes, "The earth standeth fast forever." To show the utter futility of the Copernican theory, he declares that if it were true, "the wind would constantly blow from the east"; and that "buildings and the earth itself would fly off with such a rapid motion that men would have to be provided with claws like cats to enable them to hold fast to the earth's surface." Greatest weapon of all, he works up, by the use of Aristotle and St. Thomas Aquinas, a demonstration from theology and science combined, that the earth *must* stand in the center, and that the sun *must* revolve about it.*

DOMESTIC ANIMALS IN INDIA.†

By JOHN LOCKWOOD KIPLING.

PASSING from the free to the fettered, we come to a beast which in India serves at once as an expression of wild liberty, more complete than that of the monkey, and of utter and abject slavery. For a wholly unmerited obloquy, relic of a dark aboriginal superstition, is added to the burden of toil and hard living. Yet there was once a time when in the nearer East, or ever the horse was known, he was held in high honor, carved in Assyrian sculptures, and reckoned a suitable steed for prophets and kings. Even now, in Cairo, Damascus, and Bagdad, although the Bedawi Arab pretends to despise him, he is regularly ridden by respectable people.

* For Father Inchofer's attack, see his Tractatus Syllepticus, cited in Galileo's letter to Deodati, July 28, 1634. For Fromundus's more famous attack see his Anti-Aristarchus, already cited, *passim*, but especially the heading of chapter vi, and the argument in chapters x and xi. A copy of this work may be found in the Astor Library at New York, and another in the White Library at Cornell University. For interesting reference to one of Fromundus's arguments, showing, by a mixture of mathematics and theology, that the earth is the center of the universe, see Quetelet, Histoire des Sciences mathématiques et physiques, Bruxelles, 1864, p. 170; also Mädler, Geschichte der Astronomie, vol. i, p. 274.

† Extracted from the author's recent book, Beast and Man in India, by the courtesy of the publishers, Messrs. Macmillan & Co.

The Arabian Nights story of a conversation overheard between the ox and the ass shows the estimation in which he was held; and it is written that Mohammed himself had two asses, one of which was called Yafūr, nor did that great man disdain to ride double. But here in India, by formal prescription, only the gypsy, the potter, the washerman, and such-like folk, out-caste or of low caste, will mount or own the ass. This prescription,

Fig. 1.—The Potter and his Donkey.

and the ridiculous Hindu association of the donkey with the goddess of small-pox, account for the universal dislike and disdain in which this most useful, sagacious, and estimable animal is held. He is never fed by his owners, and his chronic hunger is mocked by a popular saying that to feed a donkey is neither sin nor sacrifice.

It would seem difficult to be cruel to a goat, but the keepers of the flocks of milch-goats regularly driven morning and evening into Indian cities contrive to inflict a good deal of pain. The nipples of the udder are tied up in torturing fashion, and there is an unnecessary use of the staff. But the worst cruelty is the practice of flaying them alive, in the belief that skins thus prepared have a better quality. The magistrates in the Presidency towns

frequently have cases of this offense before them, and inflict absurdly inadequate fines.

A quaint belief is that in dry desert places where wells formerly existed goats will group themselves in a circle round the ancient well-brink, though not a trace of it is visible to the keen-

Fig. 2.—Milch Goats.

est human eye. Those who sketch animals may have noticed that goats at rest have a way of grouping themselves as if posing for their portraits. It is possible that this unconscious trick is at the bottom of the well-brink belief. So far as I know, there are no sayings which notice the fine carriage of the head and the elegant horse-like gait of this beautiful animal. The Indian goat, as a rule, is much taller and of more slender build than the European animal.

Fig. 3.—A Sporting Man.

From an administrative and economic point of view there are serious objections to the goat, which is one of the plagues of the Forest Department of the Government. It is the poor man's animal, and is supposed to cost nothing to keep. Every green shoot is nibbled off as soon as it peeps above the ground, and young trees are promptly destroyed by creatures which spend half their time on their hind legs, and have an effective reach up to the height of a man's head.

It is only in India and Peru that the sheep is used as a beast of burden. Borax, asafœtida, and other commodities are brought in bags on the backs of sheep driven in large flocks from Thibet into British territory. Only the picturesque shepherds return from these journeys; for the carriers of the caravan, feeding as they go, gather flesh in spite of their burdens, and provide most excellent mutton.

Sheep are numerous in India, but they are seldom kept by the cultivator or farmer, for the combination of agricultural with pastoral life, common in other countries, is almost unknown. In the towns of the plains rams are kept as fighting animals, and the sport is a source of gratification to many. A Mohammedan "buck," going out for a stroll with his fighting ram, makes a picture of point-device foppery not easily surpassed by the sporting fancy of the West. The ram is neatly clipped, with a judicious reservation of salient tufts, touched with saffron and mauve dyes, and, besides a necklace of large blue beads, it bears a collar of hawk-bells. Its master wears loosely round his neck or on his shoulders a large handkerchief of the brightest colors procurable; his vest is of scarlet or sky-blue satin, embroidered with color and gold; his slender legs are incased in skin-tight drawers; a gold-embroidered cap is poised on one side of his head; his long black hair, parted in the middle, and shining with scented hair-oil, is sleeked behind his ears, where it has a drake's-tail curl which throws in relief his gold ear-rings; and, in addition to two or three

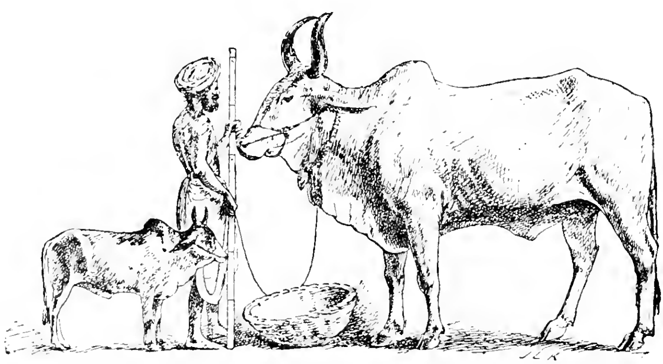

Fig. 4.—Comparative Sizes of the Largest and Smallest Breeds of Indian Oxen.

necklaces, he usually wears a gold chain. Patent-leather shoes and a cane complete the costume. As he first affronts the sunshine, he looks undeniably smart, but his return, I have observed, is not always so triumphant. The ram naturally loses interest in a stroll which has not another ram in perspective, and it is not easy to preserve an air of distinction when angrily propelling homeward a heavy and reluctant sheep.

The beauty of the cow counts almost as much as her usefulness in popular estimation, and the best breeds are really handsome. It is true that a British amateur, accustomed to the level back of the English beast, at first looks unfavorably on the hump and the falling hind quarter. The head seems too large and the body too short. But he acknowledges at once the clean, thoroughbred legs, the fine expression of the eye, the air of breeding in the broad, convex brow and slender muzzle, the character given by the deep, thin dewlap, the smooth, mole-like skin, and in the large breeds an indefinable majesty of mien. In addition to their high caste and shapely look, the hind legs are much straighter and less "cow-hocked" than those of the English animal, and are not swung so far out in trotting. On occasion the animal can jump a fence with a carriage of limbs like that of the horse. So

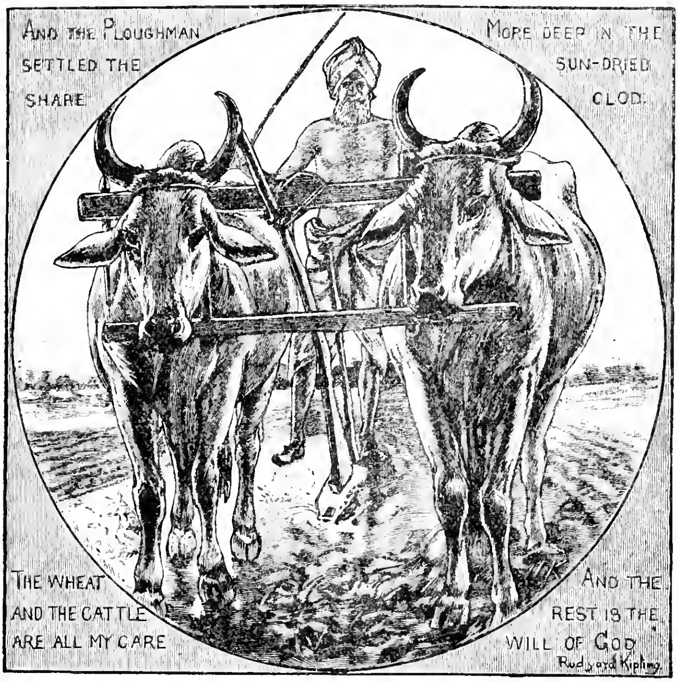

FIG. 5.—IN A GOOD SEASON.

in a very short time the Briton drops his prejudices, and is even reconciled to the hump, which, like that of the camel and the fat tail of the *dūmba* sheep, has some mysterious relation to the varying conditions of a precarious food-supply. They say vaguely it is a reserve of sustenance, but it would take a physiologist to explain how it acts. Some insist that the sloping quarter is the result of ages of scanty or irregular feeding, but it is now, at all events, a fixed anatomical peculiarity.

To the stranger the great variety of breeds and their adaptation to a wide range of needs and conditions are not at first apparent. He sees an ox and another ox as he sees a native and another native, without noticing that they belong to distinct families. Orientals have a passion for classifying things, and see scores of differences in rice, cotton, wheat, cattle, and horses, which are barely perceptible even to trained English eyes. But among cattle, though there is a bewildering variety of local breeds, some broad differences may be easily learned. The backward slope of the horns of the large and small breeds of Mysore cattle—perhaps the most popular type in use—the royal bearing of the splendid white or fawn oxen of Guzerat, and the transport and artillery cattle bred in the Government farms, at once strike the eye. These are the aristocrats of the race, but they have appetites proportioned to their size, and are too costly for the ordinary culti-

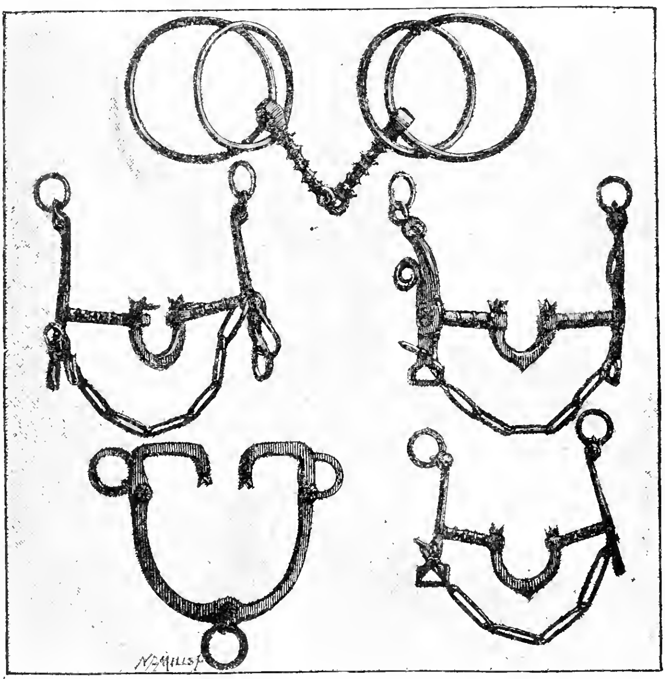

Fig. 6.—Indian "Thorn-bits."

vator. They trot in bullock coaches or draw the springless and uncomfortable but delightfully picturesque native *răth* or canopied ox-cart, the wagons of the Government commissariat and of the various Government baggage services.

India has been described by a European as the paradise of horses, and from his point of view the phrase is not unfitting. The natural affinity between horses and Englishmen becomes a

closer bond by residence in India, where everybody rides—or ought to ride—where horses and horse-keep are cheap, and where large castes of stable servants, contented with a low wage, are capable, under careful superintendence, of keeping their animals in a state of luxurious comfort. The horses, however, which serve native masters are born to purgatory rather than to paradise. Those in the hands of the upper classes suffer from antiquated and barbarous systems of treatment, and are often killed by mistaken kindness or crippled by bad training, while those of low degree are liable to cruel ill-usage, overwork, neglect, and unrelieved bondage.

Fig. 7.—A Rajah's Charger (Marwar Breed).

The "thorn-bits" here engraved are ordinary specimens of those in use; the cut requires careful examination before their murderous character can be made out. Some say the Indian bit is severe because the average horseman, being of slight build, is physically incapable of holding a horse with a fair one. There may be something in this, but the weakness is more moral than physical; nerve is more wanting than muscle, and reason most of all.

When a native chief goes out, he is accompanied by a *sowāri*—literally a "riding" of ministers, servants, guards, and attendants of all sorts. Formerly all rode; but, with good roads, good carriages have been introduced, and usually in these days only the horsemen of the guard ride. But on state occasions, led horses, richly caparisoned, always form part of the show, and there are many animals in princely stables kept solely for processional purposes. The animals most liked are the stallions of Marwar or Kathiawar. White horses with pink points, piebalds, and leopard-spotted beasts are much admired, especially when they have pink Roman noses and light-colored eyes, with an uncanny expression. Their crippled, highly arched necks, curby hocks, rocking gait, and paralytic prancing often proclaim them as triumphs of training.

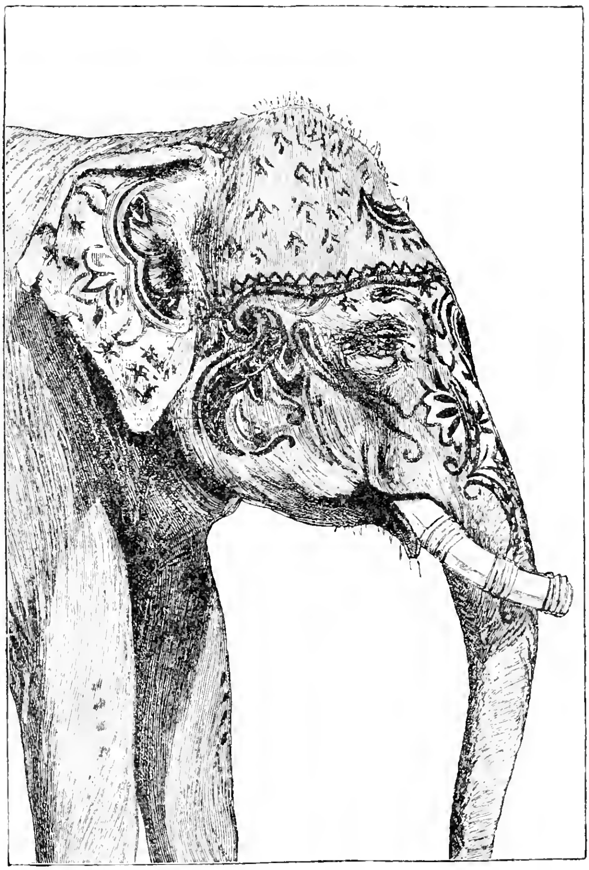

Fig. 8.—A Painted Elephant.

The docility of the elephant is never more evident than when he is dressed for parade on an occasion of state. It is a long and tiresome business to clothe the creature in the ornaments and housings with which Oriental taste loves to bedizen him. If the occasion be a very grand one, a day or two will be consumed in preparations. First the forehead, trunk, and ears are painted in bold patterns in color. This is a work of art, for the designs are often good, and the whole *serai*, excepting always the elephant himself, is deeply interested. His mind and trunk wander; he trifles with the color-pots; so with each stroke comes an order to

stand still. Some *mahouts* are quite skillful in this pattern-work. Then the howdah pad is girthed on with cotton ropes, riding over flaps of leather to prevent the chafing to which the sensitive skin is liable. The howdah itself, a cumbrous frame of wood covered with beaten silver plates, is slung and tied with a purchase on the tail-root, and heavy cloths, broidered in raised work of gold and silver thread, are attached, hanging like altar-cloths down the sides. A frontlet of gold and silver diaper, with fringes of fish-shaped ornaments in thin beaten silver, necklaces of large silver hawk-bells and chain-work, with embossed heart-shaped pendants as big as the open hand, and hanging ornaments of chains of silver cartouches, are adjusted. A cresting of silver ornaments, like small vases or fluted soup-tureens, exaggerations of the knobs along a horse's crest, descend from the rear of the howdah to the tail; anklets of silver are sometimes fitted round the huge legs,

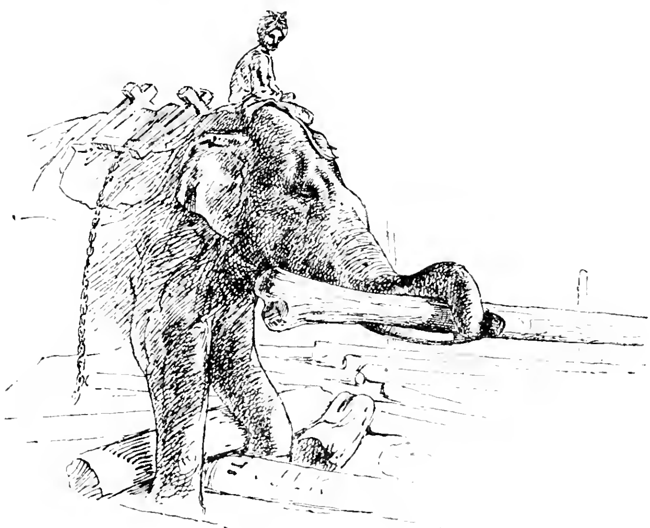

Fig. 9.—Elephant lifting Teak Logs (Burmah).

and a bell is always slung at his side. The pillars of the howdah canopies, and then the canopies themselves, with their finials, are fitted as the beast kneels.

It is officially stated that "all who have had to deal with elephants agree that their good qualities can not be exaggerated; that their vices are few, and only occur in exceptional animals; that they are neither treacherous nor retentive of injury; and that they are obedient, gentle, and patient beyond measure." This is higher and more sympathetic praise than is usually tied up in the pink tape of secretariats, and it is all true.

The normal load for continuous travel of a fair-sized elephant is eight hundred pounds, so the animal is equal to eight ponies,

small mules, or asses; to five stout pack-mules or bullocks, and to three and one third of a camel. Under such a load the elephant travels at a fair speed, keeping well up with an ordinary army or baggage train, requiring no made road, few guards, and occupying less depth in column than other animals. He is invaluable in jungle country and all roadless regions where heavy loads are to be moved. In Burmah, and on the east and southeast frontier, elephants are absolutely necessary for military supply. When once a good road is made the beast is, of course, easily beaten by wheeled carriages.

He shines most as a special Providence when the cattle of a baggage-train or the horses of a battery are stalled in a bog or struggling helplessly at a steep place. An elephant's tusk and trunk serve at once as lever, screw-jack, dog-hooks, and crane, quickly setting overturned carts and gun-carriages right, lifting them by main force or dragging them in narrow, winding defiles, where a long team can not act; while his head, protected by a pad, is a ram of immense force and superior handiness.

A born forester, it is in jungle-work that the laboring elephant, outside Government service, is seen at his best. The tea-planters of Assam and Ceylon find him useful in forest-clearing and as a pack-animal. They even yoke him to the plow. He is the leading hand in the teak trade of Burmah—unrivaled in the heavy toil of the timber-yard, where he piles logs with wonderful neatness and quickness. Small timbers are carried on the tusks, chipped over and held fast by the trunk. A log with a thick butt is seized with judicious appreciation of balance, while long and heavy balks are levered and pushed into place.

The truth about the camel's character has often been debated. He is wonderful, and in his own way beautiful to look at, and his

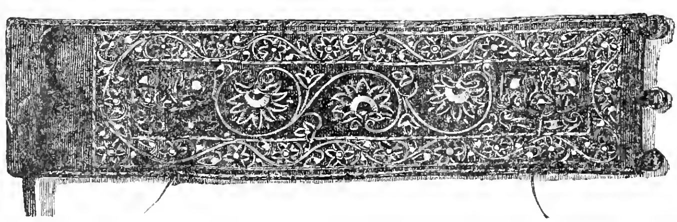

Fig. 10.—Rajput Camel-rider's Belt.

patience, strength, speed, and endurance are beyond all praise. The camel-riders of Rajputana and central India, mounted on animals of a swift breed, cover almost incredible distances at high speed, finding it necessary to protect themselves against the rocking motion by broad leather belts, tightly buckled, which are often covered with velvet and prettily broidered in silk. Even they, who know the beast at his best, never pretend to like their

mounts as one likes a horse. So useful a beast is estimable, but the most indulgent observation fails to find a ground for affection. Europeans, at all events, who have to do with camels, seem to think it were as easy to lavish one's love on a luggage-van. He is a morose, discontented, grumbling brute, a servant of man, it is true, as is the water that turns a mill-wheel, the fire that boils a kettle, or the steam that stirs the piston of a cylinder. He does not come to a call like other beasts, but has to be fetched and driven from browsing. There are but few words made for his private ear, such as belong to horses, dogs, and oxen. An elephant has a separate word of command for sitting down with front legs, with hind legs, or with all together, and he moves at a word. A camel has but one, and that must be underlined with a tug at his nose-rope ere he will stoop. But he has a large share in that great public property of curses whose loss would enrich the world.

Camel trappings are not so gaudy in India as in Egypt or Morocco, where riding animals are bedizened in scarlet and yellow. They are in a different key of color, belonging to a school of pastoral ornament in soberly colored wools, beads, and small white shells, which appears to begin (or end) in the Balkans and stretches eastward through central Asia into India, especially among the Biloch and other camel folk on our northwest frontier. Camel housings may be the beginning of the nomad industry of carpet-weaving. It is, perhaps, not too fanciful to trace on the worsted neck-band the original unit or starting-point of the carpets and "saddle-bags" which have given lessons to English upholsterers.

SOCIAL STATISTICS OF CITIES.

LESSONS FROM THE CENSUS. V.

By CARROLL D. WRIGHT, A. M.,

UNITED STATES COMMISSIONER OF LABOR.

THE social statistics of our great cities are being put into concrete form by Mr. Harry Tiffany, Chief of the Division of Social Statistics of Cities of the Eleventh Census, under the able direction of Dr. John S. Billings, U. S. Army, expert special agent of the census office. So far the returns on some important leading features comprise about fifty of the principal cities. These facts relate to streets, street-lighting, water-works, sewers, and the police and fire departments. All these, however, are among those features of municipal conditions which are constantly in the minds of men and agitating them as to expenses and the value which they secure in return for taxes paid.

The distribution of population in the fifty cities on which re-

ports have already been published should first be given in any treatment of the social statistics of cities, and the following table answers the purpose admirably well:

Population and Area of Fifty Cities, with Distribution of Population by Square Miles and Acres.

Cities.	Counties.	Population.	Area.		Population to	
			Square miles.	Acres.	Each square mile.	Each acre.
New York....	New York, N. Y.....	1,515,301	40·22	25,740·80	37,675·31	58·87
Chicago......	Cook, Ill...........	1,099,850	160·57	102,764·80	6,849·66	10·70
Philadelphia..	Philadelphia, Pa.....	1,046,964	129·39	82,809·60	8,091·54	12·64
Brooklyn	Kings, N. Y.........	806,343	26·46	16,934·40	30,474·04	47·62
St. Louis.....	Missouri............	451,770	61·35	39,264·00	7,363·81	11·51
Boston	Suffolk, Mass........	448,477	35·28	22,579·20	12,711·93	19·86
Baltimore....	Maryland...........	434,439	28·38	18,163·20	15,307·93	23·92
San Francisco.	San Francisco, Cal...	298,997	15·46	9,894·40	19,340·04	30·22
Cincinnati....	Hamilton, Ohio......	296,908	25·00	16,000·00	11,876·32	18·56
Cleveland....	Cuyahoga, Ohio......	261,353	24·88	15,923·20	10,504·54	16·41
Buffalo......	Erie, N. Y..........	255,664	39·04	24,985·60	6,548·77	10·23
New Orleans..	Orleans, La.........	242,039	37·09	23,737·60	6,525·72	10·20
Detroit......	Wayne, Mich........	205,876	20·59	13,177·60	9,998·83	15·62
Milwaukee ...	Milwaukee, Wis......	204,468	17·00	10,880·00	12,027·53	18·79
Washington..	District of Columbia..	202,978	10·24	6,553·60	19,822·07	30·97
Newark......	Essex, N. J.........	181,830	17·77	11,372·80	10,232·41	15·99
Minneapolis..	Hennepin, Minn.....	164,738	51·67	33,068·80	3,188·27	4·98
Omaha	Douglas, Neb........	140,452	24·50	15,680·00	5,732·73	8·96
Rochester....	Monroe, N. Y.......	133,896	15·60	9,984·00	8,583·08	13·41
St. Paul......	Ramsey, Minn.......	133,156	51·42	32,908·80	2,589·58	4·05
Denver......	Arapahoe, Col.......	106,713	15·49	9,913·60	6,889·15	10·76
Indianapolis..	Marion, Ind.........	105,436	10·07	6,444 80	10,470·31	16·36
Worcester....	Worcester, Mass.....	84,655	34·02	21,772·80	2,488·39	3·89
Toledo.......	Lucas, Ohio.........	81,434	19·72	12,620·80	4,129·51	6·45
New Haven..	New Haven, Conn....	81,298	7·56	4,838·40	10,753·70	16·80
Lowell.......	Middlesex, Mass.....	77,696	11·15	7,136·00	6,968·25	10·89
Nashville	Davidson, Tenn......	76,168	8·44	5,401·60	9,024·64	14·10
Fall River....	Bristol, Mass........	74,398	10·95	7,008·00	6,794·34	10·62
Cambridge ...	Middlesex, Mass.....	70,028	5·83	3,731·20	12,011·66	18·77
Camden......	Camden, N. J.......	58,313	4·34	2,777·60	13,436·18	20·99
Trenton.. ...	Mercer, N. J........	57,458	3·95	2,528·00	14,546·33	22·73
Lynn........	Essex, Mass.........	55,727	10·64	6,809·60	5,237·50	8·18
Hartford.....	Hartford, Conn......	53,230	14·66	9,382·40	3,630·97	5·67
Evansville....	Vanderburg, Ind....	50,756	4·42	2,828·80	11,483·26	17·94
Los Angeles..	Los Angeles, Cal.....	50,395	27·60	17,664·00	1,825·91	2·85
Lawrence....	Essex, Mass.........	44,654	6·67	4,268·80	6,694·75	10·46
Hoboken.....	Hudson, N. J........	43,648	1·47	940·80	29,692 52	46·39
Dallas.......	Dallas, Texas........	38,067	7·68	4,915·20	4,956·64	7·74
Sioux City....	Woodbury, Iowa.....	37,806	30·90	19,776·00	1,223·50	1·91
Portland.....	Cumberland, Me.....	36,425	2·51	1,606·40	14,511·95	22·67
Holyoke	Hampden, Mass.....	35,637	3·98	2,547·20	8,954·02	13·99
Binghamton .	Broome, N. Y.......	35,005	10·04	6,425·60	3,486·55	5·45
Duluth	St. Louis, Minn......	33,115	3·23	2,067·20	10,252·32	16·02
Elmira.......	Chemung, N. Y......	29,708	4·45	2,848·00	6,675·96	10·43
Davenport ...	Scott, Iowa..........	26,872	4·41	2,822·40	6,093·42	9·52
Canton	Stark, Ohio..........	26,189	6·80	4,352·00	3,851·32	6·02
Taunton	Bristol, Mass........	25,448	47·40	30,336·00	536·88	0·84
La Crosse....	La Crosse, Wis......	25,090	8·19	5,241·60	3,063·49	4·79
Newport.....	Campbell, Ky.......	24,918	1·20	768·00	20,765·00	32·45
Rockford	Winnebago, Ill......	23,584	6·37	4,076·80	3,702·35	5·78

The total population of the cities comprehended in the foregoing table is 10,095,370. The areas have been determined by actual

measurements, and from latest obtainable data, or from records in the offices of the city engineers of the respective cities. Fall River is an exception to this rule, as the boundaries of Wards 6 and 9 in that city have never been accurately defined. The city of Washington, in the table, includes the area and population inclosed within the actual municipal boundaries, and not the total area and population of the District of Columbia. The islands in the East River, with an area of five hundred and twenty acres, and which are geographically situated in Wards 12, 19, and 23, are included as part of New York.

The most interesting feature of the foregoing table is that relating to the distribution of population according to area; but in this one must not be deceived. The population to each acre or to each square mile of a city can not well be compared with like data for another city, unless the exact area of dense population is known—as, for instance, a city may comprise fifty square miles of territory and have 500,000 population, which would give a population of 10,000 to each square mile, but the population may be compressed into twenty-five square miles, when the actual distribution would be 20,000 persons to the square mile; while another city of like area and like total population, but with the population distributed more evenly over the whole area, would be in a much better sanitary condition than the first city named, although in statistics the population per square mile would be the same when the whole area is considered.

Twenty-two of the cities named in the foregoing table have a population of over 100,000 each, the total being 8,737,648, which is 13·95 per cent of the total population of the country. The population to the square mile of these twenty-two cities is 15·92 to the acre; but the differences in ratios of population to area are very great, ranging from four in St. Paul, five in Minneapolis, nine in Omaha, ten in New Orleans and Buffalo, eleven in Chicago and Denver, and twelve in St. Louis, to thirty in San Francisco, thirty-one in Washington, forty-eight in Brooklyn, and fifty-nine in New York. These figures represent population to a square acre. So skillful a statistician as Dr. Billings is of course careful to remark that the ratios indicated by the statistics published "give no information as to the difference in density of the population in the actually built-up portions," and he cites that in New York the number of persons per acre ranges from four hundred and seventy-four in Ward 10 to three in Ward 24, while in Chicago there is a range from one hundred and sixteen in Ward 16 to two in Wards 28 and 23. These instances show the extremes, and teach us emphatically that any comparison of population to the square acre or to the square mile for the purpose of drawing conclusions relative to sanitary and other conditions must be

avoided. Physicians have taken considerable interest in censuses, and for the very reasons stated, and so in many cases health districts have been prescribed and the statistics of population and the social facts relating to population for such health districts preserved. In this way the very best results are to be reached. With complete statistics of population for clearly defined health districts, where the sanitary conditions can be compared and differences of conditions noted, a scientific study of death-rates with reference to the density of population can be undertaken. The ordinary statistics of death-rates based on the density of population of cities are exceedingly vicious, but perhaps not more so than the ordinary statements relative to the death-rate of cities based on the whole population. There is great liability to very misleading statistics in this direction. The errors arise from two causes. The first of these is the incompleteness of death statistics. This can only be overcome by a compulsory registration of deaths. The second cause is that population is not accurately known except for periods some distance apart, and here error arises, and would arise, even with complete and perfect statistics of deaths; as, for instance, a State which depends entirely upon the Federal census ascertains its population only once in ten years. For the census year the death-rate based on population may be fairly accurate; but for intermediate years the death-rate must be based upon calculations of population mathematically made. In some cases this has led to very vicious results, and has caused considerable fright and anxiety on account of the great apparent death-rate, when, had the facts all been known, it would have been found that the death-rate was really normal. Another feature of error, or rather feature for the basis of erroneous conclusions, relative to the death-rate in great cities, arises from the fact of the existence of large hospitals in cities, and that the death-rate is increased by people coming from the country to the cities for treatment and there passing away, thus giving an abnormally high death-rate relative to the actual living population of a city. This is also true in connection with the criminal statistics of cities. Men come in from country towns for the purpose of a visit or a spree, or for carrying out some nefarious design. At all events, they commit crime, from one cause or another, within the city limits, are there arrested and punished, and their crimes help to swell abnormally the legitimate criminal statistics of the city itself. All these considerations should be taken into account when writers are undertaking to draw what they feel to be accurate conclusions through comparisons of statistics. I have read very learned essays upon conditions of the population, involving insanity, crime, disease, death, etc., when all the conclusions of the essays were based upon most incomplete

and unsatisfactory data—in fact, upon statistics that were not within a large percentage of accuracy. When treating the vital statistics of the whole country I shall take pains to call attention to some of the exceedingly misleading if not thoroughly erroneous conclusions in the past. It is exceedingly gratifying to know that the experts in charge of such important facts under the eleventh census are thoroughly alive to all the opportunities of error which ordinarily and naturally arise under imperfect statistics.

The discussions which are going on relative to municipal control will be enriched by a great many facts in the social statistics of cities that are being published under the eleventh census. The difference in the cost of building and maintaining streets and in the cost of street-cleaning, the advantages of paved or unpaved streets so far as health is concerned, and the general conditions resulting from cleanliness—all these facts can be learned when the complete statistics of cities are published. Boston, Worcester, and Holyoke are cities in which all the streets are paved; but Dallas, Texas, has but 4·7 per cent of its streets paved, St. Paul 4·1, and Minneapolis 3·1, while Denver's streets are not paved at all.

The average yearly cost of construction and repairs per head of population in cities having over 100,000 inhabitants is $1.54, while in twenty-seven cities for which the census has returns, having less than 100,000 inhabitants each, the cost is $2.04.

The average annual expenditure for street-cleaning varies from five cents in Buffalo and eight cents in Chicago to seventy-one cents in New York and sixty-two cents in Cincinnati; but, as the census officials remark, there is probably no definite relation between the cost per head of street-cleaning as shown by the figures and the actual condition of the streets as to cleanliness. Ordinary observation teaches us that in many cities where the cost is greatest the streets are in the filthiest condition.

The question as to economical street-lighting is an important one in all municipalities. The facts already published indicate that the annual cost of gas-lamps varies from $50 per lamp in New Orleans, $43.80 in San Francisco, and $37 in St. Louis, to $15 in Indianapolis and Canton, $15.60 in Minneapolis, and $17.50 in Hoboken; while the annual cost of each electric lamp varies from $68 in Chicago and $58.46 in Denver to $237.25 in Boston and $440.67 in San Francisco. When all the facts are collected and published it is to be hoped that the public can ascertain the relative advantages of the different systems of lighting, so far as cost per capita is concerned. At present the cost to each head of population can only be stated for the total average annual cost for the cities comprehended in the table. This is sixty-four cents

per annum. Not only will the facts be shown relative to the cost per capita of each method of lighting the streets of a city, whether by gas, electric light, or oil, etc., but the relative advantages of lighting streets by works owned by the city and works owned by private corporations will be shown. It is a fact that the gas-light is gradually giving place to the electric light; for, while the facts for the cities named in the tables already published by the census office show that gas-lamps comprise over sixty per cent of all classes used for street-lighting, it is evident that they are now rarely used exclusively for lighting. It is also learned that electric lighting is most favored in those cities that have less than 100,000 inhabitants each; for, in 278 such cities, out of a total of 91,667 lamps, 35,127 are gas-lamps, 35,191 are electric lamps, and 21,149 are lamps burning oil, etc. Taking the total cities from which reports have been received relative to light, being 309 cities, with a population of 16,335,569, the total number of lamps of all kinds is 293,847, the gas-lamps numbering 182,671, the electric lamps 53,696, and the oil-lamps 57,480.

The interest which now centers in the question as to whether *quasi* public works shall be controlled by private corporations or by the municipality itself is illustrated more specifically by the facts connected with water-works than by those surrounding any other character of city works, and the difference as to cost of maintenance and receipts between public and private works is very noteworthy. The facts are already given quite fully by the census for fifty cities, and of these thirty-five own their own water-works. The average cost of construction in the thirty-five cities owning their own water-works to each head of population is $21.35, while in thirteen cities where the water-works are owned by private parties the cost of construction to each head of population is $31.20, or nearly ten dollars more per capita than where the cities construct their own works. Out of 273 cities reporting to the census on their water-works, fifty-six per cent own and operate their own works, the remainder depending on private companies for their water-supply; but the fifty-six per cent represent seventy-seven per cent of the total population of the 273 cities. A greater proportion of private works perhaps are to be found in the smaller cities; for, out of 133 such cities, having a population of 3,708,994, 112 cities, representing 2,351,574 people, have their water-works operated by private parties.

The sewers of the cities of the country are under the control and direction of the municipal governments. The construction has been under public control. In Baltimore, where the sewers are intended for the removal of storm water only, is found the smallest percentage of sewers to streets in the larger cities, it being only 3·56. The cities of Washington and Cambridge have

more miles of sewers than of streets. In 190 cities the population to each mile of sewer is 1,815.

The social statistics of cities already published comprehend tables on the points which have been discussed; and, further, as stated, on the police and fire departments. In the latter two sections the chief interest relates to the cost of each force. Selecting some of the salient features relative to the police, it is interesting to learn that in New York there are 72·65 patrolmen to each square mile of territory, while in Chicago there are but 9·08, in Philadelphia 11·01, in Brooklyn 34·01, in St. Louis 8·72, in Boston 19·25, in Baltimore 21·81, in San Francisco 21·73, in Cincinnati 16, in Cleveland 10·13, in New Orleans 4·66, and in Washington 35·64.

The criminal conditions as indicated by arrests, if arrests be a fair indication, are shown by the following facts: In New York the number of arrests to each patrolman is 25·53, in Chicago 27·37, in Philadelphia 35·09, in Brooklyn 31·52, in St. Louis 32·98, in Boston 48·41, in Baltimore 42·96, in San Francisco 69·68, in Cincinnati 35, in Cleveland 29·76, in Buffalo 41, in New Orleans 86·71, and in Washington 48·71.

The question as to what a man receives for the taxes he is called upon to pay is not only an exceedingly interesting one from an economic point of view, but of real, vital consequence to the welfare of the people. I have therefore constructed an entirely new table from the various tables already reported by the census, showing the average cost per head of population in the fifty cities named for the construction and repairs of streets, for street-cleaning, for lamps of all kinds, for the maintenance and repairs of sewers, for the police force, for the fire department, and for water, with a total which all these items of expenditure make for each inhabitant in the fifty cities named. (See table on following page.)

The averages in the tables from which the foregoing is drawn are, as I understand it, for the ten years ending January 1, 1890, except in some cases where municipal governments have been of recent growth, in which cases the averages are for the years during which the work has been carried on. It is evident, however, that the averages have been very carefully worked out, and represent more forcibly than any statements heretofore published the cost in the great branches of city government in the cities named. I hope in some future paper to add the cost of the educational work of the cities, and some other features, so as to show the exact expenditures which one has to make for the maintenance of the various branches of city affairs. It must be remembered that the average cost per head of population, as shown in the last table, represents the cost to each man, woman, and child. It must also be remembered that the cost is not paid directly, in accord-

Cities.	Average Cost per Head of Population in Fifty Cities.							
	For construction and repairs of streets.	For street cleaning.	For all lamps.	For maintenance and repairs of sewers.	For police.	For fire department.	For water.	Total.
New York, N. Y....	$0.68	$0.71	$0.43	$0·077	$2.90	$1.06	$1.20	$7.057
Chicago, Ill........	3.18	0.08	0.58	0.075	0.89	0.64	2.80	8.245
Philadelphia, Pa....	0.61	0.27	0.70	0.024	0.96	0.60	1.80	4.964
Brooklyn, N. Y.....	0.49	0.20	0.59	0.066	1.07	0.70	1.60	4.716
St. Louis, Mo.......	1.85	0.28	0.43	0.057	1.05	0.62	2.80	7.087
Boston, Mass.......	1.84	0.30	1.24	0.263	2.15	1.78	2.40	9.973
Baltimore, Md......	0.28	0.25	0.70	0.023	1.56	0.35	1.40	4.563
San Francisco, Cal...	3.21	0.20	0.94	0.094	1.82	1.15	4.00	11.414
Cincinnati, Ohio.....	2.88	0.62	0.73	0.084	1.11	0.92	2.50	8.844
Cleveland, Ohio.....	1.34	0.19	0.61	0.023	0.96	0.77	2.25	6.143
Buffalo, N. Y.......	2.24	0.05	0.11	0.017	1.17	0.88	2.40	6.867
New Orleans, La....	0.14	0.10	0.71	.....	0.70	0.66	5.00	7.310
Detroit, Mich.......	1.63	0.16	0.56	0.062	1.08	1.03	2.00	6.522
Milwaukee, Wis.....	2.29	....	0.59	0.095	0.60	0.82	2.20	6.595
Washington, D. C...	2.50	0.31	0.77	0.119	1.97	0.49	0.90	7.059
Newark, N. J.......	0.11	0.16	0.67	.....	0.93	0.49	2.75	5.110
Minneapolis, Minn...	1.21	....	1.01	0.006	0.92	0.76	1.80	5.706
Omaha, Neb........	4.15	0.16	0.26	0.032	0.46	0.46	2.40	7.922
Rochester, N. Y.....	1.06	0.15	1.06	0.015	0.74	0.45	1.40	4.875
St. Paul, Minn......	5.69	0.28	1.06	.....	0.74	1.01	1.72	10.500
Denver, Col........	0.45	....	0.95	0.023	0.47	0.94	3.40	6.233
Indianapolis, Ind....	2.61	0.47	0.44	.....	0.53	0.71	2.40	7.160
Worcester, Mass....	1.65	0.08	0.94	0.112	0.87	0 59	3.00	7.242
Toledo, Ohio	4.03	0.10	0.66	.....	0.90	0.76	2.20	8.650
New Haven, Conn...	1.68	0.06	0.79	0.001	1.26	0.92	2.40	7.111
Lowell, Mass.......	1.27	....	0.73	0.167	0.91	0.91	2.60	6.587
Nashville, Tenn.....	1.71	....	0.38	0.001	0.60	0.73	4.40	7.821
Fall River, Mass....	0.89	....	0.37	.....	0.95	0.57	3.00	5.780
Cambridge, Mass....	0 64	0.36	0.69	0.174	1.02	0.85	3.40	7.034
Camden, N. J.......	0.38	0.19	0.59	0.010	0.51	0.34	2.20	4.220
Trenton, N. J.......	0.17	0.03	0.70	.....	0.96	0.38	2.00	4.240
Lynn, Mass.........	0.72	0.18	0.66	0.045	0.72	0.85	2.20	5.375
Hartford, Conn.....	0.88	0.11	0.86	0.025	1.03	1.11	1.80	5.815
Evansville, Ind.....	0.66	0.15	0.64	0.030	0.55	0.79	3.00	5.820
Los Angeles, Cal....	....	....	1.15	.....	0.57	1.33	4.80	7.850
Lawrence, Mass.....	0.74	0.07	0.34	.....	0.73	0.49	2.40	4.770
Hoboken, N. J......	0.46	0.05	0.44	0.046	0.96	0.23	2.35	4.536
Dallas, Texas.......	0.47	....	0.50	0.394	1.05	0.92	6.20	9.534
Sioux City, Iowa....	20.05	0.16	0.40	0.053	0.32	0.53	2.40	23.913
Portland, Maine.....	1.59	....	0.84	0.049	0.93	0.40	4.60	8.409
Holyoke, Mass......	0.51	....	0.61	0.561	0.56	1.13	2.20	5.571
Binghamton, N. Y...	0.43	0.03	0.63	.....	0.24	0.43	3.00	4.760
Duluth, Minn.......	15.00	0.15	0.68	0.138	1.21	1.51	4.00	22.688
Elmira, N. Y.......	0.40	0.07	0.80	0.017	0.60	0.74	3.60	6.227
Davenport, Iowa....	1.12	0.19	0.61	0.004	0.44	0.52	1.60	4.484
Canton, Ohio.......	1.22	....	0.69	.....	0.32	0.45	1 60	4.280
Taunton, Mass......	1.41	....	0.61	.....	0.74	0.51	2.60	5.870
La Crosse, Wis.....	0.81	....	0.51	.....	0.40	0.37	2.40	4.490
Newport, Ky........	0.60	0.16	0.37	.....	0.40	0.32	3.40	5.250
Rockford, Ill.......	0.51	0.08	0.51	0.013	0.32	0.51	2.20	4.143

ance with the items specified, but that to the whole city the cost per capita is as stated. According to all economists, however—and there is no reason to take issue with the proposition—the taxed cost is borne by every man, woman, and child, either directly or indirectly. It is fair, therefore, to assume that in each of the cities named, for each person there must be paid, either

directly, by an assessed tax, or indirectly, through the increased cost of articles of consumption, of rent, etc., the cost specified.

The column for water is not particularly satisfactory, although it is indicative of the actual expense. The census tables show only expense of annual charge for water for an average dwelling, meaning by an average dwelling one that is occupied by one family and not exceeding seven rooms, with one bath-room, including hot and cold water, and one water-closet. If an average dwelling is one occupied by one family, then one fifth of the annual charge for water as given in the census reports would show with reasonable accuracy the charge for each individual, and on this basis the column for water has been constructed.

Looking at the items for each of the fifty cities named in the last table and the total, we easily ascertain what a man receives for the tax which he is obliged to pay directly or indirectly, and also in which city he receives the most for his money, or, rather, where he receives all his protection of police, his use of streets, his protection from fire, etc., for the least expenditure, and the analysis also leaves in each man's mind this question: Could he secure so great a return for his money by any other method of expenditure?

There are a few blanks in the table just given; as, for instance, in New Orleans the expense for the maintenance and repairs of sewers is missing, and this item is also omitted from the reports for Newark, St. Paul, Indianapolis, Toledo, Fall River, Trenton, Los Angeles, Lawrence, Mass., Binghamton, Canton, Taunton, La Crosse, Wis., and Newport, Ky. There are also a few other points missing; as, for instance, the expense of street-cleaning in Milwaukee, Minneapolis, Denver, and some other cities. These points, however, comprehend nearly all the omissions, and in so far as they occur the total expense in the cities named is vitiated, although to a very small extent.

Taking the table as it stands, it is seen that Rockford, Ill., offers the most for one's taxes of the smaller cities, it being $4.14 per capita. Camden, N. J., comes next, with $4.22; and Trenton follows, with $4.24. Among the larger cities, those having over 200,000 inhabitants, Baltimore offers the very lowest expense for her great departments of government, the per capita expense for all being $4.66. Brooklyn, N. Y., comes very close, the expense being $4.71, and Philadelphia ranks third as to cheapness of municipal government for the items named, the expense being $4.96. The great city of New York, about which so much is said relative to her expensive government, furnishes the seven items of expense named in the table at $7.05 per capita, being lower than St. Louis, Chicago, Boston, San Francisco, Cincinnati, or New Orleans, and ranking almost exactly with Washington. The most expensive

city on the list is Sioux City, Iowa, and the next is Duluth, Minn., the expense being in the first $23.91 and in the second $22.68; but this great expense is probably due to the extensive construction of streets in a recent period, and therefore the expense of these two cities should not be compared with that of others. Throwing out the cities with abnormal conditions, it is probable that San Francisco is the highest cost city in the list of fifty given in the table, the expense being $11.41 per capita.

The table will be found interesting in many respects, as comparisons can easily be made for one city with another, not only as to total per capita cost, but as to the items enumerated. Looking at the city of New York, for instance, the table means that it would cost a family of five $35.25 per annum for the benefits accruing to it from the use of streets and the cleaning thereof, for public lighting, for the maintenance and repairs of sewers, for police protection, for the protection of the fire department, and for the use of water. No one can object to an expense for a family of five persons no higher than that named for all these great advantages. The working-man with five in his family is not taxed this $35.25 directly, as intimated, but he has to pay it in rent and the cost of his living. Is it an unreasonable addition to his annual expenses? is the question. It does not matter whether the total expense is high or low for all the advantages detailed; the great question is, Could they be furnished as efficiently and as well in every respect for a less sum, with the integrity of all departments preserved? If they could, then a man is entitled to the less expense. If not, he should certainly be entirely satisfied with the great return which he now gets for the money expended.

WAYSIDE OPTICS.

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OUR train has been traveling for the past twenty-four hours over that part of a transatlantic route which stretches from the Sierra Madre to the extreme borders of the great Mohave Desert. There are many interesting things to be seen along this line of travel, but nothing more striking than the curious optical phenomena presented by the pleasing alternation of vast plain with rugged mountain. For example, not far from the last station we come upon a lofty peak overtopping the surrounding hills. It seemed to be about ten miles away, but was in reality fifty.

As is well known to the student of optics, the apparent size of an object is mainly dependent upon the size of the image which

it makes upon the retina, just as its apparent distance from the observer is determined chiefly by the distinctness of the impression formed upon the background of the eye. The rays of light reflected from the distant mountain made a distinct image upon my retinæ because they traversed a rarefied atmosphere of uniform density which produced the minimum amount of refraction, dispersion, and absorption. Previous to this time I had been accustomed, under Eastern skies, to view distant objects through media neither so rare nor so uniform as this mountain air, and it was not, therefore, strange that my calculations of distance should in this case be erroneous. Such phenomena, familiar enough to most travelers and to every dweller in the "cool, thin atmosphere" of mountainous regions, are almost startling when seen for the first time. It is difficult to believe that the huge, stony mass, apparently so near—certainly so plainly seen—is over half a hundred miles away.

The illusion as to distance does not, however, extend to the matter of size. Mountains and hills may, under certain atmospheric conditions, appear to be near at hand when they are actually far away, but their apparent size remains always the same. The same mountain would appear of just the same size in Colorado as in Vermont. We know this because objects equally distant and of the same size always subtend the same visual angle. The greater the distance from the eye, the smaller the visual angle and retinal image; the less the distance, the greater the angle and the larger the image—as the following diagram (Fig. 1) shows:

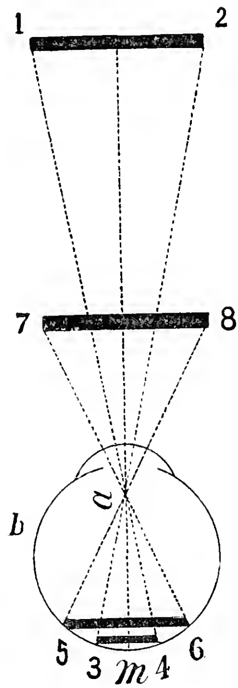

Fig. 1.

The rays of light falling through the pupil upon the retina, *b m c*, cross at the nodal point *a*. The near object, 7 8, subtends a larger visual angle, 7 *a* 8, and makes a larger retinal image, 5 6, than the distant object, 1 2.

It would be interesting to test the truth of these statements by actual experiment, if ideas of size and distance did not, unfortunately, vary with the individual, and were not subject to almost daily modification by experience and other influences. Calculations as to the actual size and distance of the most familiar objects are, within certain limits, but pure guesses on the part of the great majority of people; so that, even if it were worth the while, the most of us could never become experienced enough,

by making a study of distant objects, to do more than roughly approximate their actual size and distance away.

In making estimates of this kind we are, in the latter instance, very materially assisted by the peculiar "distance tints" which the mountains assume. The brain becomes accustomed, after a large number of experiences, to associate a certain coloration of objects with certain distances from the eye, and in this way to calculate the distance of an object seen for the first time. Einthoven thinks that the chromatic aberration which even a normal eye exhibits may account for the peculiar colored appearances which distant objects take on.

This explanation is manifestly opposed to the view commonly held, that the minute globules of water in the air act as prisms, and, resolving white light into its component colors, robe the distant mountains in "azure hues." In either case the peaks of the Sierras would deceive the unfamiliar eye, for not only are they more distinctly seen than their fellows of the Atlantic States, but their "distance tints" would entirely mislead the unaccustomed observer.

As the train proceeds rapidly over the level desert my eyes "fix"*—i. e., gaze steadily at—a clump of sage-bush which is probably two miles distant. The bush seems to move slowly *with* the train, while objects between it and my eyes have an apparent motion in the opposite direction. Of these latter the near ones fly past with great rapidity, but the apparent velocity of those farther removed diminishes until, just before the point of fixation is reached, objects come to an apparent standstill. Beyond the point fixed by my eyes objects move in the same direction as the train, their velocity apparently greater the farther away they lie.

Suddenly I shift my gaze from the sage-bush to a large bowlder which is sailing slowly past, probably one thousand yards from the train. Everything is changed at once. The bowlder's retrograde progress is arrested; near objects fly past with accelerated speed; the sage-bush clump forges ahead as if to make up for lost time, while the plain beyond it, indistinct in the distance, races ahead of every object in view. And so I while away a full half-hour, making one conspicuous object after another stand still, go ahead, or sail past at will—all upon the surface of this apparently boundless plain—trying to realize, meantime, that things are *not* as the moving panorama before me indicates. For, relatively to the train, all objects are passed at an equal rate, the near as well as the distant, those seen by direct as well as those seen

* When the eye fixes anything, the visual apparatus is so adjusted that the rays of light coming from the object are focused upon the *macula*, a small central spot in the retina, where vision is most acute; and the object thus fixed is seen more distinctly than surrounding bodies.

by indirect vision. But, in looking from my car window, I am made the subject of optical illusions common in a journey of this sort.

Notwithstanding the many wonderful things about the mechanism of vision, it exhibits, after all, a great many crudities. Intellectually, for instance, the optic centers are low down in the scale of origin. Even the olfactory nerves have a higher cerebral origin than they. Accordingly, we often find them committing all sorts of errors, from whose consequences only the experience of the other organs (acting as special detectives) enables the organism to escape.

Simple "seeing" ought not to be followed, in all cases, by implicit belief. When, for example, as in this case, the eye forms part of a moving mass, the motion is wrongly attributed by the optic centers to surrounding bodies. The explanation of how this comes about is easy when one considers certain facts in elementary optics. If I close one eye and slowly move a pen from right

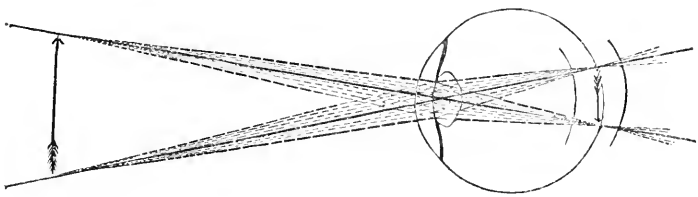

Fig. 2.

to left a few inches in front of the other eye, the direction of the movement is rightly interpreted by my brain, although by a reference to Fig. 2 it will readily be seen that the retinal image of the pen moves in an opposite direction over the background of the eye.

Precisely the same effect is obtained if, instead of moving the pen, I look straight forward and move my head from left to right, simply because the same impression is produced—i. e., the retinal image moves from left to right.

When, therefore, the image of an object is made, it matters not *how*, to move over the retinal background, motion in an opposite direction is immediately referred to the object itself. It makes no difference, then, so far as the optical effect is concerned, whether the solid plain with the objects on its surface be carried past the observer at rest, or whether the observer himself move past or over the plain. Further, when there is no movement of the image over the retina, no motion is detected by the eye; optically, the object is at a standstill. That a body moving in front of the eye should appear to be stationary, its image must always be kept in the same position on the retina. This is accomplished

by the alert ocular muscles. When, however, the object is too near the eye, or when its motion is too swift, the muscles are not quick enough in their action to preserve this delicate state of optical rest; the image is thrown across the retina, and the object is seen to move. A glance at this diagram (Fig. 3) will show how these retinal impressions are received and interpreted.

The first figure is intended to represent three objects seen from a train in motion. Although the middle one is fixed by the eye, and is consequently most distinctly seen, the blurred images of the other two also fall upon the macula, so that for a single instant they are all optically at rest. A moment later, the eye, still fixing the middle object, has moved from 1 to 2, and, as is seen in 2, the images corresponding to the near and the remote objects have passed over the retinal area. Motion in the opposite direction is, according to the law just laid down, attributed to each, while the middle object still gives the impression of comparative rest.

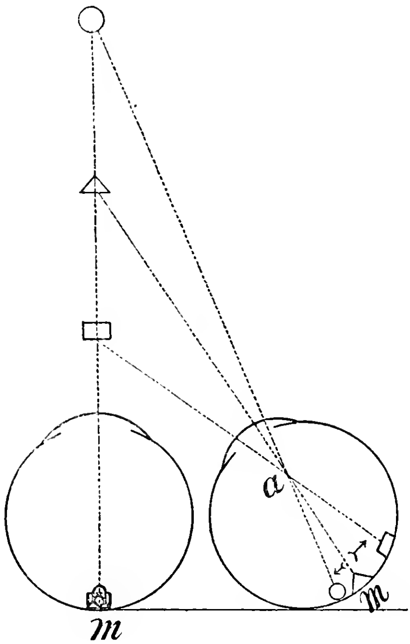

Fig. 3.

When, however, the image of the moving object is kept fixed upon the macular region, the eye may judge of the rate of its motion by *the amount of effort* put forth by the ocular muscles necessary to keep the image focused upon the macula.

This method of calculation is defective, and gives rise to numerous optical errors. For example, the movement of a lady's fan in front of her face, the velocity of a base-ball through the air five hundred yards off, and the rate at which the night express travels as it approaches "end on"—its head-light gleaming in the distance—would all be incorrectly calculated if the brain were to accept ocular evidence alone and based on one or both of the foregoing rules. The to-and-fro movement of the fan would be interpreted as exceedingly quick; the velocity of the base-ball would be next in order; while little or no motion would be attributed to the approaching train.

Becoming tired of looking at the wayside scenery, I find myself, in a sort of brown study, watching the back of the plush-covered seat in front of me, and then I discover that the retinal

impressions made by the moving pageantry of the Arizona desert are curiously transferred to this crimson background. For I see a strip of plush moving irregularly to the right of me, and just above it another section moving to the left.

As the movements of the plush correspond very nearly to the previous visual impressions made by the moving landscape, I soon find that I can vary the plush movements at will.

Allowing sufficient intervals of rest to elapse, I am able to make an upper segment of the plush cushion move slowly backward or forward in contrast with a lower portion—a faithful photograph from the landscape negative.

This persistence of strong or continued retinal impressions may easily be demonstrated by another and commoner experiment. Look intently for two or three minutes at the light falling through a small window, other illumination being excluded. Then close the eyes and place a bandage over them. The impression produced by the light persists several minutes, and the experiment will be all the more striking if the window be crossed by bars, the persistent images of which are seen distinctly in strong contrast to the lighted spaces surrounding them.

Kühne, of Heidelberg, and others have shown that the retina possesses a pigmentary substance (visual purple), sensitive to light, which acts like the sensitized plate or film of the photographic camera, and that a picture distinctly seen is actually photographed upon the background of the eye.

Looking from the rear platform of our vestibule train—an admirable vantage-ground from which to view the country through which one is passing—I find that we have just skirted some foot-hills and are approaching the mouth of a small cañon, at the head of which a bold, black mountain looks threateningly down on the desert below. The train once more gains the level country, and on looking back, although it is far up the gorge, the mountain seems very near. Nay, more, as I look first at the road-bed and then at the base of the huge mass in front of me, the latter, in some uncanny way, follows, as if it wished to fall upon and crush me. This apparent motion reminds me of Shelley's description:

> "The Apennine in the light of day
> Is a mighty mountain dim and gray,
> Which between the earth and sky doth lay;
> But when night comes, a chaos dread
> On the dim starlight then is spread,
> And the Apennine walks abroad with the storm."

Not so, however, is it with this particular outpost of the Sierra Madre. The fact is that while I have, at the car window, been experiencing the retinal effects produced by objects moving in a

direction apparently parallel to the horizon, I am now having an object-lesson in optics with bodies whose apparent motion is at an angle to the horizontal line. In both these cases the explanation of the observed phenomena is precisely the same. The body of the mountain represents the most distant objects on the level desert, its base is the point of fixation, while the near objects are between it and the receding train.

The rails, sleepers, and the gravel fly past with a velocity which apparently diminishes in the distance; the mountain-base is practically at a standstill, but beyond it is the prominent bulk of the mountain itself, which appears to advance in obedience to the laws we have just been considering.

But my cerebral convolutions refuse to accept such evidence. They insist, these maturer products of the evolutionary force, that the organism has never had any experience of mountains chasing railway trains. And so it happens that I, placing my trust in an enlightened experience rather than in a report from my childish optical centers, feel assured that this particular mountain is *not* following us.

The prevailing idea that the organ of vision is practically a perfect piece of optical and nervous mechanism has done not a little to discourage attempts to develop those wonderful powers which it undoubtedly possesses.

One may, by judicious education, train and improve an undeveloped sense, but what improvement can be wrought in a perfected organism?

Far too little has been done in this direction, not only among children during school life, but in after-years spent at literary, technical, or other institutions. Of course, it may be asserted that the sense of sight, in conjunction with the other senses, receives its due share of developmental training in the ordinary course of general and special instruction. But, as opposed to this, may be urged, in the first place, the *natural deficiencies* of the eye, a few of which have just been referred to; and, in the second instance, the splendid results which, despite these innate defects, are obtainable by judicious training—results richer far than any other sense is capable of attaining.

This plea for a systematic exercise of the visual functions does not exclude the payment of proper attention to the other senses. It is asserted merely that our knowledge would be more complete if a larger proportion of the time and attention given to the cultivation of the special senses were devoted to the development of the capable but congenitally deficient organ of vision.

As a preliminary to this there should never be forgotten the *care of sight*. A great deal has been said (and too much, perhaps, can not be said) about the importance of ocular hygiene, especial-

ly as applied to schools and school children; but, in addition to these sanitary measures as applied to the mass, inspection of *individual* cases should be insisted upon. How many useful eyes might have been saved to the commonwealth if they had been examined and treated early in life by a competent oculist!

It is a rule—to which there are few exceptions—that, in addition to those defects which all eyes possess in common, the human organ of sight is, about the school age, prone to certain diseases, arising from inherent anomalies of structure, from heredity, from the results of infantile diseases, and from other causes. It is also true that many, if not most, of these dangers to which the eye in after-life is subject may be warded off by precautions suitable to individual cases. Thus the *myope*, or short-sighted person, should exercise care of a kind quite different from that which is suitable to the *hyperope*, or long-sighted individual; while the unfortunate astigmatic child (with "blurred" sight) should follow a prophylactic programme of a kind distinct from either; and so on through the list of possible ocular defects, which, although they commonly elude even the watchful eye of parent or guardian, are still possible sources of future disease. The advance of ophthalmological science has reached that point where one may read in the defective eyes of childhood the record of a large percentage of the impaired, restricted, or lost vision of later years.

MUSICAL INSTRUMENTS—THE ORGAN.

By DANIEL SPILLANE.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XIII.

THE organ is the most magnificent and comprehensive of all musical instruments. While the pipes of Pan—aside from that mythical personage—indicate a very ancient use of pipes as a means of producing musical sounds, the "water-organ of the ancients" furnishes to the student of organ history the first tangible clew regarding the remote evolution of the instrument. In the second century the magripha, an organ of ten pipes with a crude key-board, is said to have existed, but accounts of this instrument are involved in much obscurity. It is averred that an organ—the gift of Constantine—was in the possession of King Pepin of France in 757; but Aldhelm, a monk, makes mention of an organ with "gilt pipes" as far back as the year 700. Wolston speaks of an organ containing 400 pipes, which was erected in the tenth century in England. This instrument was blown by "thirteen separate pairs of bellows." It also contained a large key-

board. There are drawings of that period extant, which represent the organ as an instrument having but few pipes, blown by two or three persons, and usually performed on by a monk. The keys, which were played upon by hard blows of the fist, were very clumsy, and from four to six inches broad. About the end of the eleventh century semitones were introduced into the keyboard, but to all appearances its compass did not extend beyond three octaves. The introduction of pedals, in 1490, by Bernhardt—giving a compass B flat to A—was another important contribution to the instrument. These were merely small pieces of wood operated by the toe of the player.

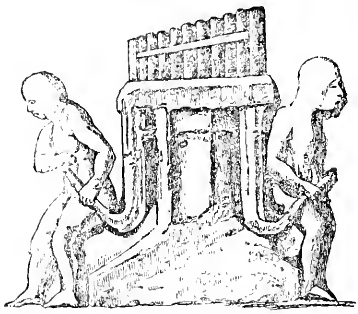

Fig. 1.—Antique Sculpture in the Museum of Arles, dated XX.M.VIII, representing organ blown by the mouth.

Jordan's "swell organ," which was introduced about 1712, in England, is deservedly ranked as one of the greatest advances in organ-building known up to that year. Jordan was renowned among the builders of his century. Green, another noted English builder of the period, improved the swell and added a score of lesser innovations which give him a prominent place in histories of the instrument. Milton was cheered and consoled in his blindness, as we learn from his biographers, by a portable organ. This was a form of instrument called the regale, which was in use during the sixteenth and seventeenth centuries. It has, however, been obsolete for over a century.

From being a mere accessory to church choral services, the organ has been improved in time by the introduction of stops, instrumental effects, and the extension of pedal and manual compass, until it has attained such a recognized position as a solo instrument that it might now be called an orchestra in itself. In the last century the men notably associated as builders with its progress were Jordan, Green, Schroder, Silberman, Snetzler, Harriss, Avery, Bywell, and Father Schmidt. Frescobaldi, the organist, who wrote the first fugues and musical compositions according to the highest capacities of the organ in his lifetime (1580–1640), gave the development of the instrument a great impetus. Stradella, J. S. Bach, Handel, and Albrechtsberger followed as executants and composers of organ

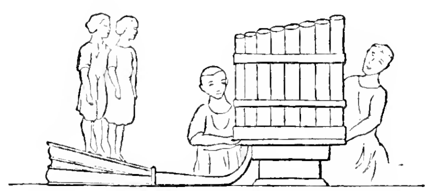

Fig. 2.—Representation of an Organ on an Obelisk at Constantinople, erected in the fourth century.

music. Each of these eminent musicians assisted in the improvement of the instrument by suggestions given to the celebrated builders of his time. The builders of the seventeenth and eighteenth centuries were great enthusiasts in their art, and every fresh development in the region of tones and effects was introduced with considerable *éclat*. Of the old effects still in use, the Kremhorn (Cremona), the Gemshorn, and Hohl flute stops are most generally known. As we behold to-day the magnificent instruments in European and American churches and concert auditoriums from the workshops of the representative builders of both continents, we are given much to contemplate from a mechanical and artistic point of view, while the wonderful musical effects that they are capable of producing tend to fill us with awe and profound pleasure.

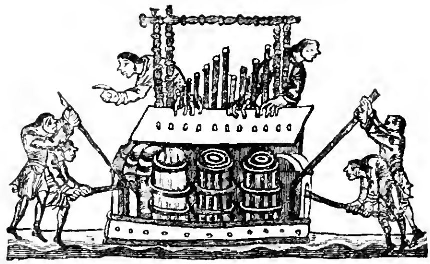

Fig. 3.—Curious Drawing from MS. Psalter of Edwin, in the library of Trinity College, Cambridge, England.

Among the most famous of the old organs in Europe is the Haarlem instrument, built by Christian Müller, of Amsterdam (1735–'38). This is celebrated as one of the largest and finest in the world. It has a manual compass of 51 notes, CC to D in alt, and a pedal compass of 27 notes, CCC to tenor D. It has 60 stops and 4,088 pipes, divided as follows: Great organ, 16 stops, 1,200 pipes; choir, 14 stops, 1,268 pipes; echo, 15 stops, 1,098 pipes; pedal, 15 stops, 513 pipes. The chief accessory stops, movements, etc., are: (1) Coupler choir to great; (2) coupler echo to great; (3, 4) two tremulants; (5) wind to great organ; (6) wind to choir organ; (7) wind to echo organ; (8) wind to pedal organ—with twelve bellows nine feet by five. This magnificent instrument lacks the advantages of modern organs in the general action mechanism. The Haarlem organ can not be played without the expenditure of considerable muscular energy. The organist has to strip to his duties like a wrestler, and when the performance is over he withdraws covered with perspiration. Though endowed with wonderful musical effects in the extent and variety of its stops and combinations, these have been lost hitherto, owing to the disabilities of the manual and pedal action. Modern develop-

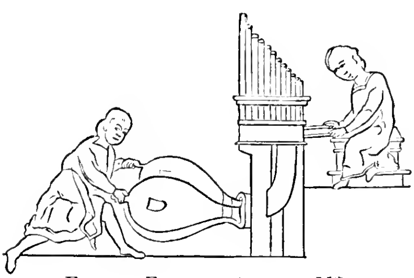

Fig. 4.—From an Ancient MS.

ments in mechanics, and particularly the application of pneumatics, as shown in the magnificent American instrument by Jardine & Sons recently erected in the Brooklyn Tabernacle, have rendered the most complicated and extended *ensemble* effects capable of easy expression, while allowing the organist that amount of muscular repose necessary for the mental demands of his art.

The Spaniards brought over the first organs heard on this continent, but so little is known concerning the subject that the historic attempt of Thomas Brattle to introduce an organ into the King's Chapel, in Boston, in 1713, may be accepted as the earliest reliable contribution to American organ history on record. Brattle's organ is at present in St. John's Chapel, Portsmouth, N. H. Thomas Brattle, a native of Boston, after whom Brattle Street and Brattle Square are named, imported the organ referred to. He bequeathed it to the Brattle Street Church, provided "that within a year from his death they would procure a sober person who could play skillfully thereon with a loud noise, otherwise to the King's Chapel." Whether it was owing to the inability of the management of the favored church to procure a "sober person" capable of playing with a "loud noise" on that historic instrument—which is rather an aspersion on the ability of Boston organists of the time, as well as a reflection on their muscular capacity—or through prejudice against the instrument as an alleged agency of the evil spirit, matters little now; suffice it for the historian to say that it was refused. It was accordingly thrown over on the congregation of King's Chapel and practically sent begging an owner, for King's Chapel also refused to accept it. The executors of Brattle's will having done their duty in the order intimated, refused to cart it away, and after considerable discussion it was allowed to lie in the porch of the church unpacked. It rested there for seven months, until the question was reopened in 1714, ending with the erection of

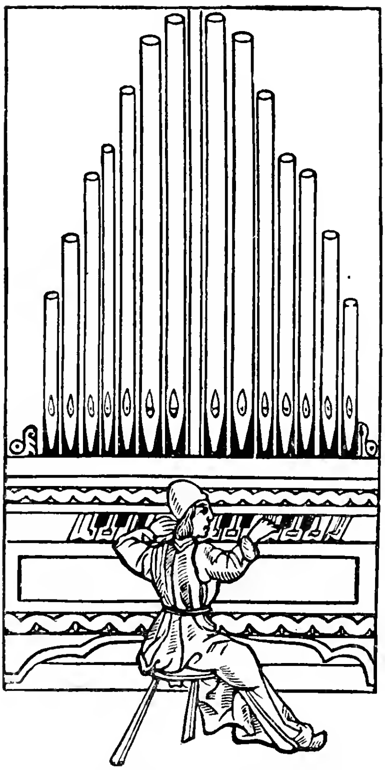

Fig. 5.—From an Ancient Engraving, showing early key-board.

the instrument. Here it was used from 1718 to 1756, when it was sold to St. Paul's Church, Newburyport. In 1836 it was transferred to St. John's, Portsmouth.

It has been generally accepted that Edward Bromfield, Jr., of Boston, built the first American organ, in 1745. The writer, however, is in a position to assert that, although a venerable piece of musical history, this is not a fact. Mr. J. W. Jordan, Assistant Librarian of the Pennsylvania Historical Society, who has paid special attention to the subject, recently discovered that Mathias Zimmerman, of Philadelphia, a carpenter and joiner, built an organ in that city some time before 1737. In his will, probated in 1737, he bequeathed the organ to a nephew, hoping that he would learn to play on it, adding that if not it could be sold to advantage, owing to its being so much of a curiosity. The record of Zimmerman's will forever disposes of the time-honored belief regarding Bromfield.

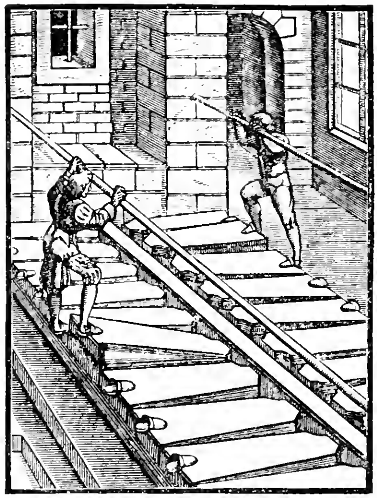

Fig. 6.—Method of blowing described by Prætorius; representing the old organ in the Church of St. Ægidien, Brunswick.

The Germans and Swedes were the chief organ-builders in America during the last century. In Pennsylvania, where several colonies located, no less than four organ-builders of note practiced their art from 1740 to 1770. These were Gustavus Hesselins, John Klem, David Tanneberger, and Robert Harttafel. Mr. Jordan, to whom I also owe the foregoing information, says the first named was a Swede. He adds in a communication, "Tanneberger's reputation as an organ-builder stood very high, and I know of at least one of his fine instruments still in use."

The Moravians of Bethlehem, in that State, were particularly noted for their connection with musical art during the last century, and their descendants manifest the same faculty. The annexed extract of a letter from Hesselins, of Philadelphia, to Rev. J. C. Pyrlaens, Bethlehem, May 28, 1746, has some value to students of national musical history: "I hope Mr. Klem will see the organ well and safe in your hands." The following is another record of a more explicit nature: "Received, June 9, 1746, of Jasper Payne, of Bethlehem, four pounds and three pounds for the half set of pipes, and one pound for coming and putting the organ up." (Signed) "John Klem, organ-builder." Franklin, in writing

to his wife, in 1756, remarks that he "heard very fine music in the church" (at Bethlehem), that "flutes, oboes, French horns, and trumpets accompanied the organ."

After Bromfield, the next organ-builder in New England was Thomas Johnston, who built an instrument for Christ Church, Boston, in 1752. He is known to have supplied the Episcopal Church in Salem with another organ in 1754, containing one manual and six stops. This pioneer maker died in 1769. Dr. Josiah Leavitt, a physician of Boston, became interested in the art through intercourse with Bromfield, with the result that he subsequently devoted himself to practical organ-building for many years, with a fair measure of success. The next organ-builder in New England after Johnston was Pratt, who went out of the business toward 1800. William M. Goodrich, a native of Templeton, Mass., born in 1777, began to build organs in Boston in 1803. He was a pupil of Leavitt, and was the first native-born organ-builder who achieved a worthy place in that noble art. Several eminent makers graduated from the sho t of Goodrich, the principal being Thomas Appleton, many of whose instruments are still in use. Ebenezer Goodrich left his brother's shop and began organ-building in 1816 on his own account. He drifted into partnership with Thomas Appleton subsequently, but after a few years they separated. Thomas McIntyre, another early Boston builder of note, appeared in 1823. This maker also left many fine instruments behind him as examples of his skill. Though Goodrich, McIntyre, and Appleton accomplished much, taking into account their opportunities, the times they labored in, and the class for which they catered, the organs they built are insignificant beside more modern products of the Hook & Hastings, Erben, Jardine, and Roose-

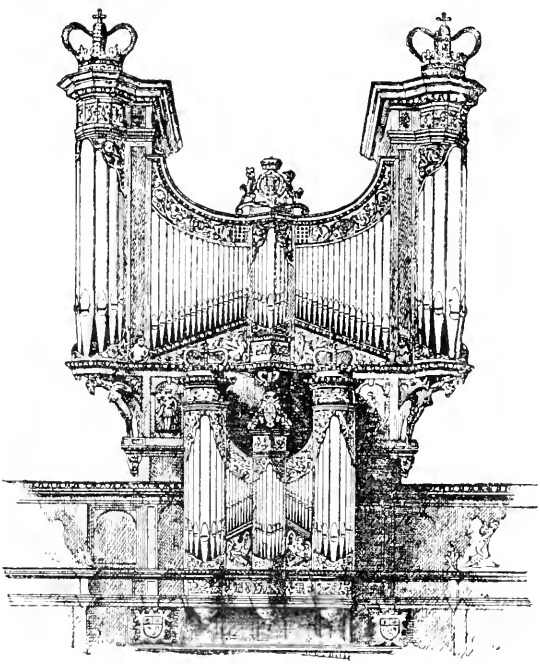

Fig. 7.—King's College, Cambridge, England. Built by Dallam, 1605-'6.

velt establishments. Meanwhile the development of organ-building in this country, it must be remembered, depended almost wholly upon the disposition of church patrons and clergymen to follow the example of their European brethren in giving the instrument a place in religious ceremonials. As evidenced in the Brattle incident, much prejudice formerly existed against the

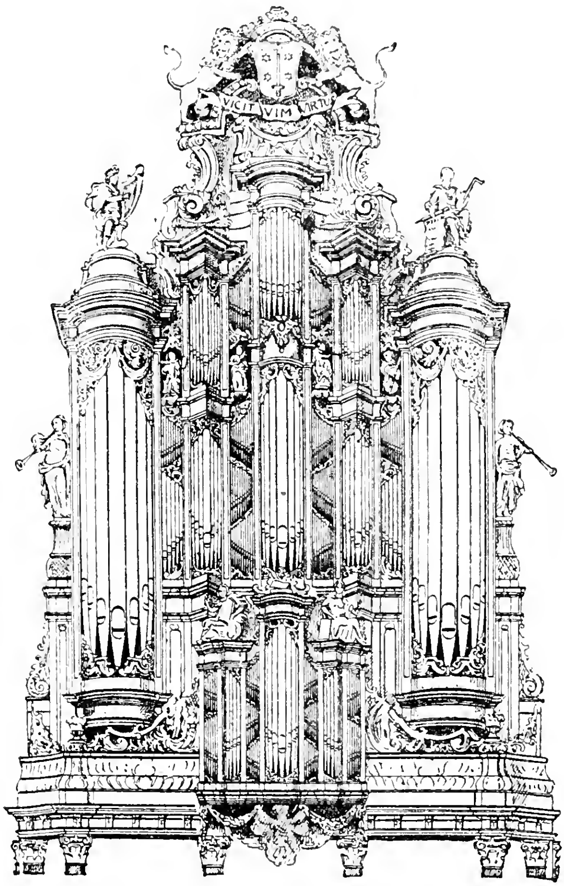

FIG. 8.—HAARLEM CATHEDRAL. Built by Müller, 1735-'38.

use of the instrument in church services among the Protestant sects—the predominating element—but, unless in very rural districts, none of this feeling now persists.

The Hooks, precursors of the celebrated firm of Hook & Hastings, Boston, were the first builders in New England to display individuality and a desire to adopt new improvements in their instruments. The Hook brothers, Elias and George G., began business in Salem, Mass., in 1827. Elias, the practical head of the

business, was, like Appleton, a graduate of the elder Goodrich's establishment. Winning notice toward 1832, they removed to Boston, and there entered on a remarkable career, in time forming the firm of Hook & Hastings, now known throughout America as organ-builders of the highest rank. Hook & Hastings came into being in 1865, through the accession of Mr. F. H. Hastings, an expert workman and a graduate of their shop. The Hook brothers died within a year of each other, George C. Hook passing away in 1880, at the age of seventy-three; Elias, the founder of the house, in 1881. The business thereupon devolved on Mr. Hastings, who has conducted it since then with much success. Evidences of the great skill of Hook & Hastings are scattered all over the continent. Among their important instruments may be mentioned the organ in Music Hall, Cincinnati, built in 1878, which is one of the largest in the country. The Tremont

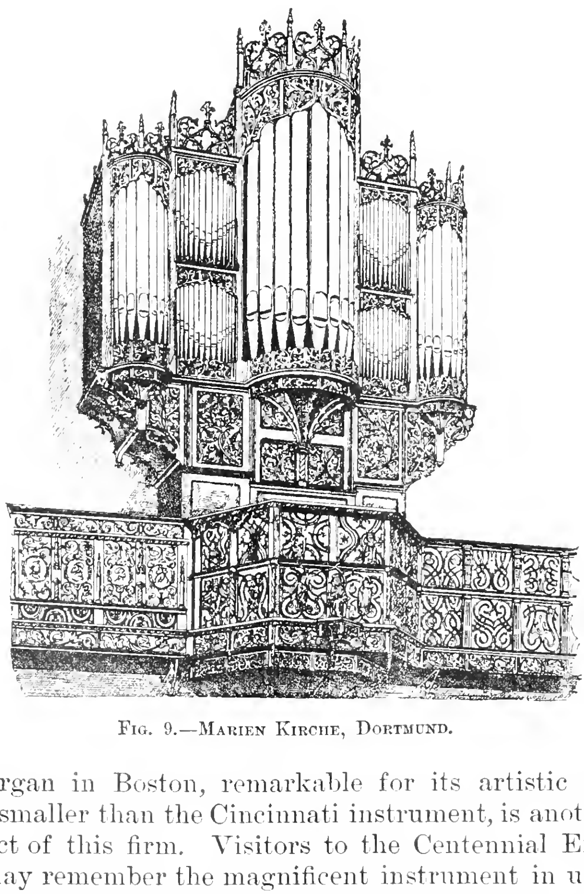

Fig. 9.—Marien Kirche, Dortmund.

Temple organ in Boston, remarkable for its artistic qualities, although smaller than the Cincinnati instrument, is another notable product of this firm. Visitors to the Centennial Exhibition in 1876 may remember the magnificent instrument in use there; this was also supplied from the same establishment. These instruments are equipped with every mechanical and scientific de-

vice requisite for bringing their immense resources under control of the organist. Mr. Hastings, while adopting many innovations from European sources, improved upon them materially in his method of application; his coupling and draw-stop system, in particular, being most sympathetic and effective in operation. These organs possess remarkably well-balanced tonal qualities also, being free from the prevailing acoustic defects apparent in large instruments of some makers.

Organ-building, like all the arts, was encouraged in New York to a greater extent than elsewhere in the years preceding the Revolutionary War and immediately afterward. The spirit of

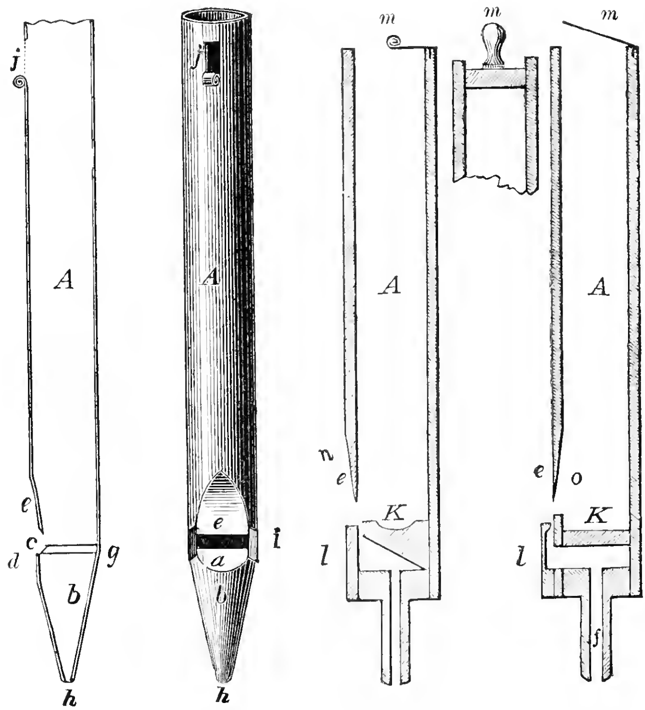

FIG. 10. FIG. 11. FIG. 12. FIG. 13.

FIGS. 10 AND 11.—FLUE-STOP PIPES, showing general features of construction: body of pipe (*A*), foot (*b*), mouth (*c*), lower lip (*d*), upper lip (*e*), air passage (*f*), languette which divides tne body of the pipe from the foot (*g*), wind entrance (*h*), ears for steadying the wind (*i*), and tuner (*j*). Figs. 12 and 13 represent section of a wood pipe of the same order: the difference is shown in block (*K*), cap (*l*), tuner (*m*), exterior bevel (*n*), inverted mouth (*o*).

liberalism found its expression in the practices and observances of church bodies, too, and a desire to erect imposing organs in keeping with the custom obtaining in English communities was manifest. Geib, who built the old Grace Church instrument, was censured severely at the time of its construction for his inability to complete an organ of more massive proportions and capable

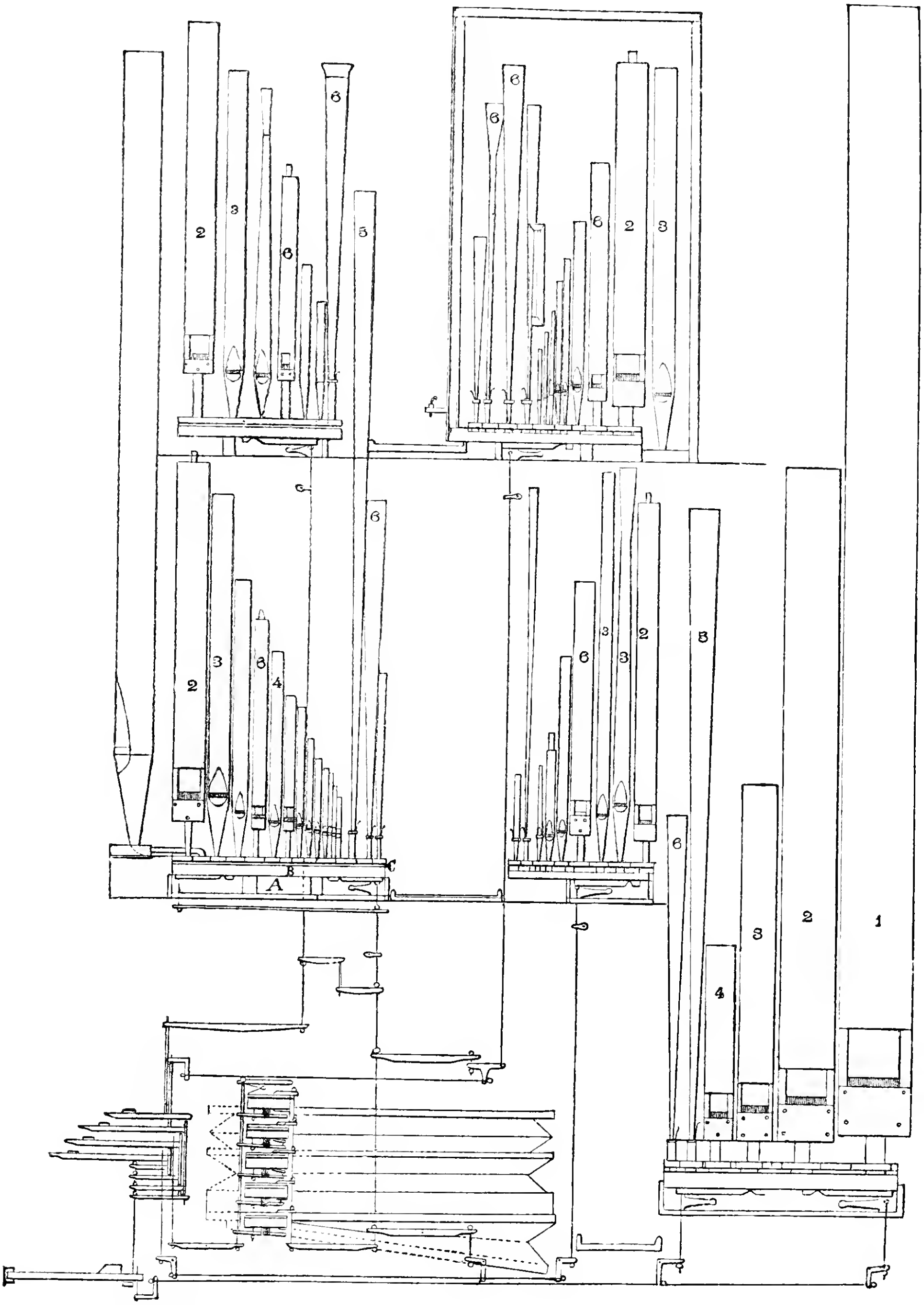

Fig. 14.—General Plan of a Four-manual Grand Organ (St. Patrick's Cathedral, New York), showing wind-chest of great organ (A), sound-board (B), and sliders or registers (C). (For further exemplification of action principles see Fig. 15.)

of more extended effects. It was the original intention of the patrons of the church at that period to have an instrument equal to some of the famous organs abroad; but Geib and his contemporaries would not undertake what they looked upon as an impossibility to them with their limited facilities and limited capacities. There was then talk of bringing over an instrument from London; but Geib's friends succeeded in putting the contract in his hands, satisfied to accept the best results he could produce. In the mean time the money saved was put to other account, so the story goes. Certain it is, however, that the first notable examples of the art of organ-building were produced in New York. Adam Geib, the builder referred to, came to New York in 1760. In that year he began business on a very unpretentious scale, but attained some note soon after the conclusion of the war. He was succeeded by two sons. John E. Geib, the best known, remained in the business until past 1830, and was looked upon as a very skillful builder.

Loew and Hall were builders of some mark in years past. The first named erected a fine instrument in St. John's Chapel. Hall served his apprenticeship with Loew, and was, in a minor sense, an originator and inventor of note. Hall was in business in New York from 1812 until 1875, when he passed away, at the age of eighty-five. A noted individual came forth from the workshop of Thomas Hall, during the early days of his business career, in the person of Henry Erben. Erben was such a remarkable youth that he was taken into partnership by Hall in 1827, just after concluding his apprenticeship. Separating from Hall in a few years, he established a business of his own in New York. Erben was fortunate enough to secure the contract for the organ in Trinity Church during his first labors, and this brought him reputation and status in his art. It is by no means a remarkable instrument, though of large proportions. Erben's later efforts were indicative of more originality. He introduced some improvements in the disposition of the general action of the instrument about 1860, which, though credited to him largely as his own inventions, were nevertheless adaptations of ideas copied from abroad.

Jardine & Sons, of New York, have taken out several important patents for organ improvements, besides constructing instruments of rare excellence embodying a hundred features of originality of the unpatentable order. In applying pneumatics to the action of the organ they have been particularly successful. Their patent pneumatic vacuum and tubular systems, also methods for controlling the registers by piston-knobs, are singularly effective devices. These are intended to facilitate execution, while rendering the manual and pedal actions easy and

sympathetic to every demand of the artist. Mr. A. J. Hipkins gives the following account of the introduction of pneumatic action, the most valuable of modern developments, in the organ: "The late Mr. Joseph Booth, of Wakefield, was the first organ-builder to whom the idea seems to have occurred of establishing

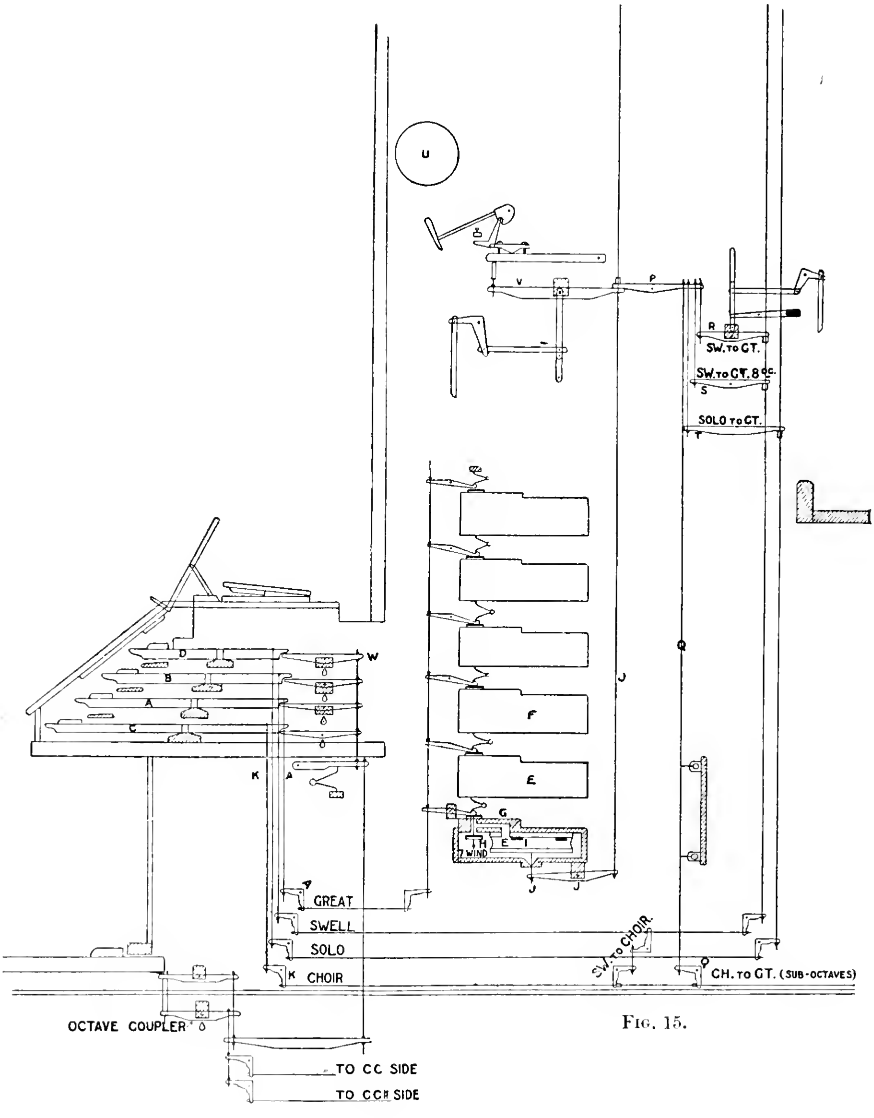

FIG. 15.

pneumatic agency, and of thus ingeniously turning the wind-power, one of the organist's antagonists, into his assistant." (Mr. Hipkins means the pressure of wind which impedes touch through the pallets, not the wind-power through which sound is

produced.) "It was to some of the bass pipes of the organ he built for the Church of Attercliffe, near Sheffield, in the year 1827, that Booth first applied his little invention. The lower notes of the wood open diapason of the GG manual were placed on a small separate sound-board, and to the pull-down of each pallet he attached a small circular bellows underneath. From the great organ sound-board groove a conveyance conducts wind into this bellows, which, opening downward, draws the pallet with it. These small bellows Mr. Booth used to call 'puff-valves.'"

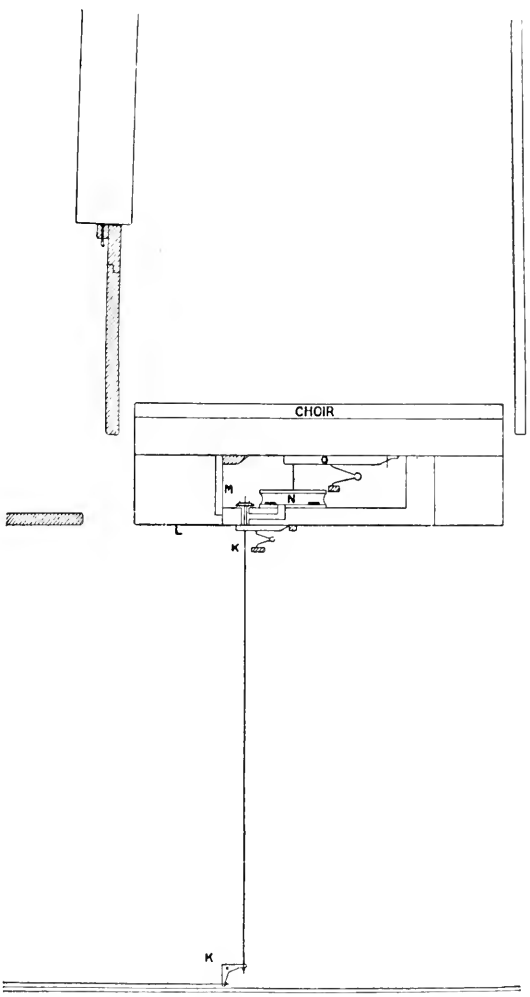

Fig. 15.—Sectional View of Organ in the Brooklyn Tabernacle, illustrating the pneumatic and general action principles embodied (erected 1891). The great organ keyboard in the above cut, also trackers and connections, are indicated by *A* throughout.

Since Booth's experiments in this direction many European builders, among them Cavaillé-Coll, of Paris, have contributed to the application of pneumatics, with the most remarkable results. American builders have not been behindhand either in adapting and improving upon the inventions of their contemporaries abroad, and their work is to be found illustrated in the magnificent instruments erected in various cities throughout the States. Jardine & Sons are admitted a leadership by the fourscore and odd organbuilders who constitute the business in the United States and the British Dominion. The founder of this eminent house, George Jardine, was born in Dartforth, England, November 1, 1801.

He learned his business with Flight & Robson, the famous English builders, and proved a workman of rare ability. In 1837 he arrived in New York, bringing over his family with him. American organ-building was in an embryo state at the time, and Jardine was compelled to put his mechanical skill to account in other directions; but he found an entry into the business in due time. Working along in an unpretentious way, he awaited an opportunity to show his ability. The Church of St. James gave him a contract for a small instrument, and the outcome laid the basis of his fortune. E. G. Jardine, his son, who had been educated to all the niceties and comprehensive details of the business, was taken into partnership in 1860, and upon the death of his father became the head of the firm. This gentleman has traveled extensively in Europe, where he studied the celebrated works of Cavaillé-Coll and other noted builders to acquire a broader insight into his art. During recent years Jardine & Sons have erected the following instruments: Fifth Avenue Cathedral, St. George's, St. Paul's, M. E., Holy Innocents, New York; Pittsburgh Cathedral, Mobile Cathedral, Christ Church, New Orleans, and the Brooklyn Tabernacle organ, all these being four-manual organs, besides a vast number of other notable instruments, which can not be specified here. George Jardine died in 1883, leaving a name destined to live among the world's greatest organ-builders of this century.

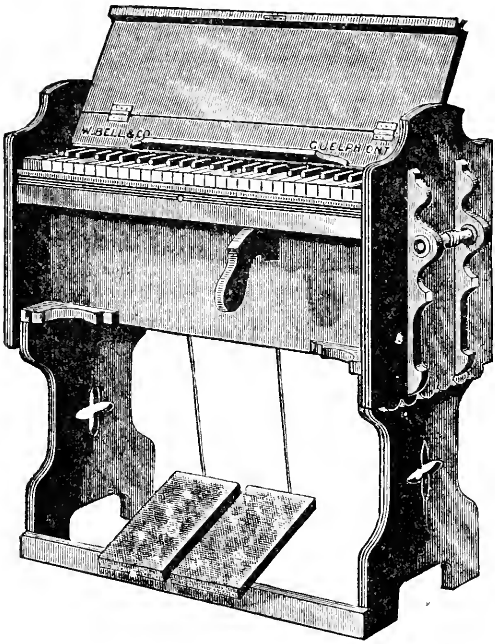

Fig. 16.—Early Precursor of the American Parlor Organ.

The present condition of the art of organ-building in America is further exemplified in the magnificent concert instrument erected in the Auditorium Building, Chicago, by the Roosevelt house of New York. Hilbourne L. Roosevelt, the founder of this house, was a native of New York, who was educated to a scholastic pursuit. Interest in the instrument as a boy led up to an enthusiasm for the mechanical and artistic possibilities which it em-

bodied, and believing himself capable of contributing to its perfection, Roosevelt entered the sphere of organ-building with love for the art, personal genius, and money to back up his ambition. Though cut off prematurely in 1889, he had succeeded in winning fame as an inventor and builder of the highest character. The instrument designated alone proves the capabilities of the house and the value of the mechanical and scientific principles which Roosevelt developed and helped to put into practical effect. Among his numerous innovations, which created considerable interest and discussion, was his arrangement of the swell effect. For instance, in a two-manual instrument of ordinary dimensions and capacity he inclosed all the pipes in a swell-box of his own construction and design, which enabled the executant to produce better *nuances* leading from *forte* to *piano*, or *vice versa;* at least, the champions of the Roosevelt system asserted these claims, while there was also a strong opposition among organists to that method of construction. I think, however, that the Roosevelt system will prove a valuable feature in time; at present it is somewhat immature and crude. Mr. Roosevelt also carried the principle into the region of three and four manual instruments. In the latter almost all the total register of tones can be brought under the influence of the swell at pleasure. This is accomplished by inclosing the various organs, solo, etc., constituting the abstract instrument, in separate swell-boxes, part of the grand organ being also partly inclosed. Apart from his original departure in the swell movement, Mr. Roosevelt introduced several notable improvements in the action of his three or four manual instruments. In the application of electricity and pneumatics to the instrument as well as in the region of tones this maker further displayed his remarkable ability. The Auditorium organ is an eloquent illustration of Roosevelt's capacity; the Garden City Cathedral instrument is another magnificent example of what the Roosevelt shop was and is capable of accomplishing. Though the late Mr. Roosevelt was the genius of the house he founded, the business is still carried on with success on the lines he laid down.

Johnson & Sons, of Westfield, Mass., are known as capable and progressive makers, destined through their past work to reach a high position in the future. William A. Johnson, the head of the business, has brought forth many inventions of value. In the region of voicing—a most important function—his son, W. M. Johnson, is regarded as an expert of the first order. Hutchings, Plaisted & Co., another Boston firm, have won considerable notice for their instruments within the past twenty years, many of which contain improvements of value, and are found in leading churches throughout the country.

The general principles of the Jardine Tabernacle organ shown

in the accompanying plan will give the reader an idea of the modern improved organ, its wonderful mechanical and acoustic features, which involve such interesting complications of pipes, sound-boards, bellows, and draw-stop, mutative stop, manual and pedal action, through which one individual—the organist—can control a great domain of musical resources at one time.

The present organ is in singular contrast with the organ of

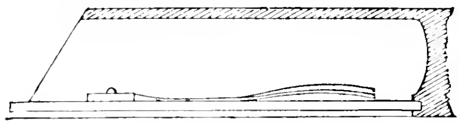

Fig. 17.

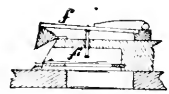

Fig. 19.

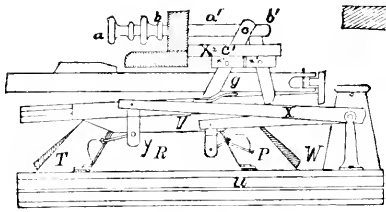

Fig. 18.

Fig. 21.

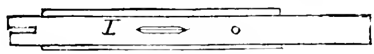

Fig. 22.

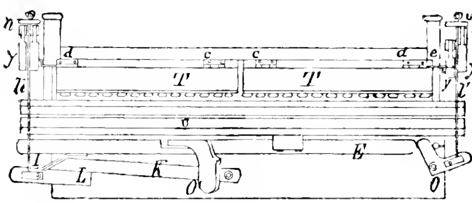

Fig. 20.

Figs. 17 to 22.—Representing Constructive Principles of a Mason and Hamlin Organ. Fig. 17 shows position of reed; Fig. 18 represents in sectional elevation part of one end with reed-valves and stop action; Fig. 19 shows auxiliary mutes; Fig. 20 exhibits method by which the stop-valve is mounted: wind-chest (*V*), reed-valves (*I*), stop-valves (*T*), swell-cap (*V*) with the swell-lids attached (*W*), stop-lever (*X*), transverse roller-lever (*b'*), roller-board (*c'*), name-board (*a'*), draw-stops (*a* and *b*), and the tube-board (*R*). Some connections of the parts are indicated thus: The inner end of stop-valve (*T*) attached to tube-board (*R*) by butt-hinge (*e*); similar hinge (*d*) fastened to outer end of tube-board; stop-valve (*T*) joined to half hinge (*d*) by the bent wire (*e*); connection of bent wire (*e*) with stop-lever (*X*) by the link (*y*); brass incline (*g*) on stop-lever (*X*); also connection of stop with valve (*P*) at the back of tube-board (*R*). Figs. 21 and 22 represent relative parts according to exemplification.

past centuries. As a musical instrument, presided over by one mind, it is incomparably ahead of any other musical medium known, in the extent of its development, aside from its capacities in the artistic sphere. To dwell for a while upon its construction: Pipes in the organ are of two kinds, wood and metal, and of two acoustic classes—namely, reed and flue. The grouping and arrangement of the huge body of pipes which enter into the compo-

sition of large organs—many of them containing over six thousand—so as to get them under the command of the narrow compass of the manuals, reveal wonderful ingenuity, quite apart from the musical effects capable of being represented through the instrumentality of that noble art medium. Formerly the pipes were attached to one key-board. Then came the disposition of the pipes with two manuals and two cases. These were consequently termed double organs. A modern instrument is found in many instances to contain five separate organs within its case, but being all under the control of the organist, they are spoken of compositely as one instrument, though particularized in giving a description by their names—grand, swell, solo, choir, and pedal. Emphasis has been laid on these points in order to give readers a clear idea of the terms used elsewhere in speaking of the instrument.

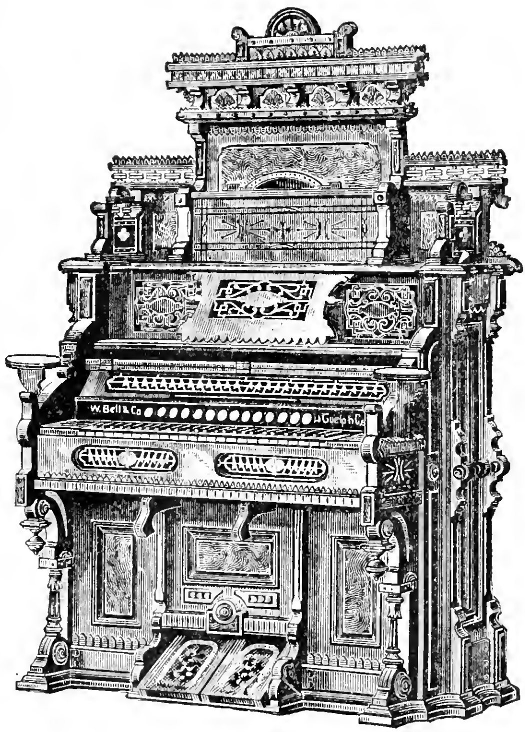

Fig. 23.—Popular Style of Modern Parlor Organ.

The aim of the organ-builder has been to increase the variety and extent of the sounds, so as to render them available for art purposes through the instrumentality of the key-board and pedal system. And in the order of things, when the number of pipes was added to from time to time to give increased compass, it became necessary to originate improvements in the wind collecting and distributing departments. These are, first of all, the bellows, then the wind-chest, wind-trunk, and sound-board grooves. Meantime it is seen that the perfection of this department, so to speak, was such that it permitted the builder to apply air to the action mechanism according to the laws of pneumatics, with obvious advantage. In the early centuries the instrument was blown with a rude bellows by hand; then came the pedal bellows described by Prætorius, in 1620, which he found in the ancient organ in the church of St. Ægidien, in Brunswick. This system re-

ferred to—working them by the feet, the blowers holding on to a rigid transverse bar as they moved along the row (the bellows described by the authority named numbered twenty, and were operated by two men)--was, however, known a thousand years previous, in Constantinople. Passing over incidental contributions to that department, it is only necessary to point out that the demands upon the wind became so great in time that it was deemed necessary to introduce mechanical means for supplying and regulating the supply required. A hydraulic engine, invented by Joy and Holt, of Middleborough, England, though defective in some respects, was the first thing found to answer the purpose. Next came a water-moter, invented by Thomas Duncan, which met with some favor. Latterly, gas and electricity have been applied with much success, and in the operation of the most comprehensive organs little difficulty is experienced at present in supplying and regulating the stock of wind required.

When the organ-builder increased the compass of the instrument and its effects, the perfecting of the key movement, the invention of the draw-stop action for controlling the use of the various tiers of pipes, the introduction of composition pedals, couplers, and other features became necessary as a part of the major development, viz., the modern great organ as it stands. Of electricity and pneumatics nothing more need be said save that these agencies have been found invaluable in operating massive instruments.

A description of the Tabernacle organ in Brooklyn will show the mechanical and scientific points of interest contained in a modern instrument of that class: The great-organ key-board (A) is capable of controlling all the others—namely, swell (B), choir (C), and solo organ (D). In effect, the great-organ keyboard through the tracker (A) and squares (A) opens the ports of the pneumatic chest (E), the interior of one of which is shown. This is filled with compressed air of a power and quantity capable of raising a column of water seven inches. When the key is pressed, or operated, it opens the vent-valve (G) and closes the supply-valve (H). The compressed air from the chest presses on the top of the small bellows (I), one of which is furnished to each note, and the wind, consequently escaping through the vent-valve, *pulls* the wire of lever (J) and tracker (J). This passes up and pulls open the big valve in the great-organ wind chest, and affects all the other organs also, when coupled on to the tracker indicated.

To explain the action of the choir key-board (C): On being pressed, the key (C) opens the train of trackers and connections (K); the vent-valve (L) in that chest is opened, which closes the supply-valve (N), thereby allowing wind to escape from the small

pneumatic bellows (N), which, being pressed down by the force of compressed air from the wind-chest, opens the large valve (O). This supplies all the pipes in that chest with wind. The swell (B) and solo (D) key-boards also operate their respective wind-chests on the same principle.

The couplers are operated through the medium of lever (P), which is controlled through a block glued on the tracker (J). When the performer desires to couple the choir to the great organ, the draw-stop pulled out has the effect of pushing the square (G) up against the tracker (K), when the desired result is attained. Again, when he wishes to couple the swell to the great, the pulling out of the draw-stop brings up the lever (R) against the block on the tracker in that connection. The coupling of the swell octave is attained by the levers (S), which are placed at an angle so as to pull the tracker of the swell one octave higher, by an ingenious movement. In coupling the solo organ to the great, the lever (T) is moved up to the block on the tracker of that manual. A little study of the plan, and the points given, will explain the general system of action very clearly. In this instrument a set of bells of three octaves (U) are operated from the great-organ key-board by a mechanism of the square piano order; pneumatic agency is also used here, as the pressure of the key will not of itself furnish the dynamic impulse necessary to put them in vibration. This is attained by a draw-stop, which puts lever (V) and tracker (J) in connection by pushing the former up against the latter. To play any of the key-boards by pedals, a "cam" serves to raise the levers (W) to the tail of the keys, thus establishing a connection.

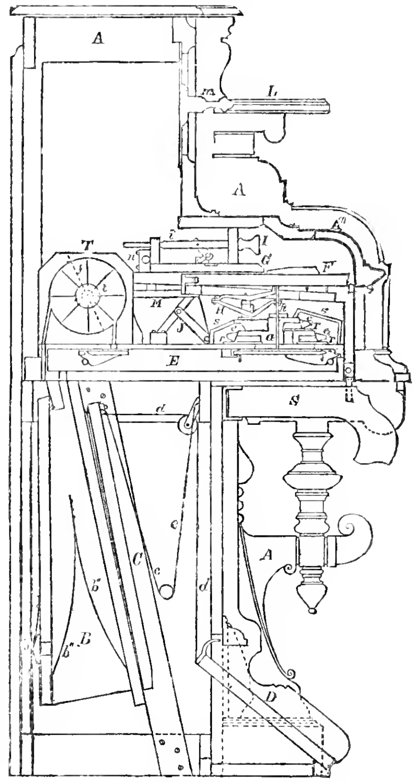

Fig. 24.—General View of Interior of Parlor Organ (Estey system).—Case (*A*), lid to key-board (*A''*), bellows reservoir (*B*), escapement (*b*), treadle (*D*), tape connecting *D* with *C* (*d*), wind-chest (*E*), reed-socket (*e*), reeds (*r r*), dampers (*e*), swells (*s*), octave-coupler levers (*H*), tracker-pin (*h*), key (*F*), name-board (*G*), stop-knob (*I*), stop-rod (*i*), lever and link for swells (*J*), slide for opening dampers (*M*), grand-organ roll (*n*), vox humana tremolo (*T*), float-wheel of tremolo (*t*), fan (*f*), music-support (*m*), lamp-stool (*L*), and knee-swell lever (*S*).

Among the special effects in this organ not specified are a bass-drum and tympani (kettle-drums), also operated by pneumatic agency. The great and swell organs are on a four-inch wind; the choir is on a three-inch; the thirty-two-foot and sixteen-foot open diapasons are on a seven-inch wind. In the region of tones may be found a German gamba—a unique stop with a string tone—and a *vox humana* copied from the celebrated instrument at Freiburg by Mooser. The *vox anglica* in the organ treated on is a remarkable expression effect, while the song-trumpet stop is a startling acoustic development. It is of such immense power that it is capable of leading eight thousand voices. The instrument also contains combination piston-knobs under the key-board and a combination pedal to every organ. These are adjustable. There are in all 110 stops and 4,448 pipes, divided as follows: Great organ, 18 stops, 1,464 pipes; swell organ, 18 stops, 1,342 pipes; choir organ, 12 stops, 854 pipes; solo organ, 8 stops, 488 pipes; pedal organ, 10 stops, 300 pipes; also 10 couplers, 11 mechanical movements, 6 pneumatic piston-knobs in great organ, 11 combination pedals, and 6 pedal movements.

The four manuals contain five octaves each, with an auxiliary pedal compass of two and a half octaves. The wind is furnished by three immense bellows of various wind pressure, operated by a C. & C. electric motor of an improved order on an Edison circuit. Its exterior, moreover, is most striking. It shows a façade of richly decorated pipes forty feet in width and fifty feet in height, and is altogether one of the finest instruments in appearance and effect in this country, and an imposing exemplification of American organ-building.

The Parlor Organ.—Sound is produced in instruments such as the French and English harmonium and the American parlor organ through the medium of the free reed. The latter, though related to the former in a physical and mechanical sense, is in many respects so different from the European reed instruments of the class designated that it is entitled to stand alone as an instrument peculiarly American and distinct in point of construction.

The individuality of the American parlor organ rests largely upon the system of reed structure invented in this country, upon which a tone has been evolved which is easily distinguished from that produced by the reed instruments made abroad. Several other features in its interior construction and exterior finish, however, distinguish it from the reed instruments called harmoniums produced in Europe. The "free reed," as it was first applied in American accordeons and seraphines, was not by any means a domestic invention, as writers recklessly assert. It was used by European pipe-organ builders for stop effects, and also in a sepa-

rate key-board instrument, prior to 1800. The "free reed" is so named to distinguish it from the "beating reed" of the clarionet and the "double reed" of the oboe and bassoon. It consists of a strip of flexible metal adjusted on a pan over a slot in which the reed vibrates on being set in motion by a current of air, thus producing a musical sound. Pitch, the height or depth of sounds, is regulated by the size and structure of the reed and pan, the smaller reeds producing the sharpest and the larger the gravest tones, while *timbre,* or quality, one of the three chief characteristics which a sound possesses, is conditioned by the structure of the reed, the nature of the metal used, and other incidental influences.

The seraphine was the first instrument of the class produced in America. It was invented by Mr. Chadwick, an American, and was merely a slight advance on the accordeon, its precursor, which was also a key-board instrument. The melodeon appeared about

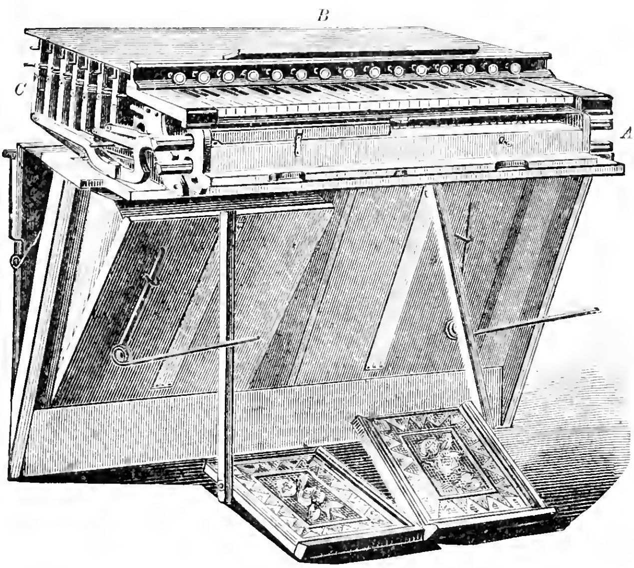

FIG. 25.—SHOWING BODY OF ORGAN REMOVED FROM CASE (Peloubet system, Lyon & Healy, Chicago, manufacturers).—Ends of mutes belonging to two full registers of reeds (*A*); stop-board (*B*), with knobs in front; upright forked levers for stops (*C*). Also illustrates general principles.

1840, and differed little from French harmoniums until Emmons Hamlin—afterward one of the founders of the celebrated firm of Mason & Hamlin—introduced some significant improvements in the construction of the reed. The improvement was of a highly important character from the historical point of view, since it was the first and chief step toward the American parlor organ. Hamlin found that, if the tongue of the reed were slightly twisted or

bent, a better quality of tone could be produced. This discovery was made in 1848. Subsequent experiments yielded remarkable results, and a new instrument was practically introduced. Meanwhile the discovery of the method of reed structure referred to has been a subject of dispute for years, the late Mr. Riley Burdette and others claiming to have anticipated Hamlin. As neither took out a patent, I can only give the version most generally accepted. In 1847 the two leading American firms devoted to the melodeon were Prince & Co. and Carhart & Needham, both located in Buffalo, N. Y. Hamlin was a clever workman and tuner in the employ of Prince & Co., to whose benefit he turned his discovery up to 1854, when he joined the celebrated Dr. Lowell Mason and founded the eminent Boston firm yet bearing their names. Other makers were not slow to copy the invention, and it became a commonly accepted principle in the melodeon within a few years.

The use of these instruments became wide-spread from 1850 upward, many patented improvements being brought forward in the interval in the acoustic and other departments. Of these, Jeremiah Carhart's invention of the exhaust or suction bellows in 1846 was the most significant. Harmoniums, so called, were also produced in this country similar to those of Alexandre, of Paris, but they varied little from seraphines and melodeons except in matters of detail. Carhart's bellows became generally adopted subsequently, and at this period is used exclusively in American organs. The old method of playing air upon the reeds yet obtains in Europe, owing to the claim that it secures more prompt speech, while the opposite method is employed in this country.

Toward 1861 the first instruments resembling the modern parlor-organ appeared. The case became individualized, new tone effects were added, two or more sets of reeds employed, and the name of "organ" applied formally. Mason & Hamlin first used the term in instruments of that improved order in 1861 which they named "organ harmoniums," to distinguish them from melodeons and harmoniums. In a few years it became "organs." Prince & Co., Carhart & Needham, and other makers contributed to the later developments in special directions, but to the firm of Mason & Hamlin is conceded the claim that they were the first to introduce the parlor organ in the year designated.

The organ business grew so rapidly that a great many new firms entered the field before 1870, some of them yet existing. Among the older houses yet devoted to this industry are Clough & Warren, of Detroit, and Estey & Co., of Brattleboro, Vt., both being founded about 1850. In the organs of both of these firms technical and acoustic ideas of a special nature are to be seen. This must also be said of instruments produced by more modern

firms. But in the abstract the organs produced by the leading makers approximate in most respects, all aiming after the same artistic results. The most elaborate and costly organs, however, come from the workshops of Mason & Hamlin, who deserve special recognition for their untiring efforts to elevate the instrument in artistic character and status. The present head of the firm, Mr. Edward Mason, is a grandson of Dr. Lowell Mason, and a native of Boston, where he was born in 1858. The founders of the business have all passed away.

There are many other excellent organmakers in the United States, some of whom are better known in Europe than in this country, strange as it may seem. The number of organs exported annually is very large, and of these the West contributes a goodly share.

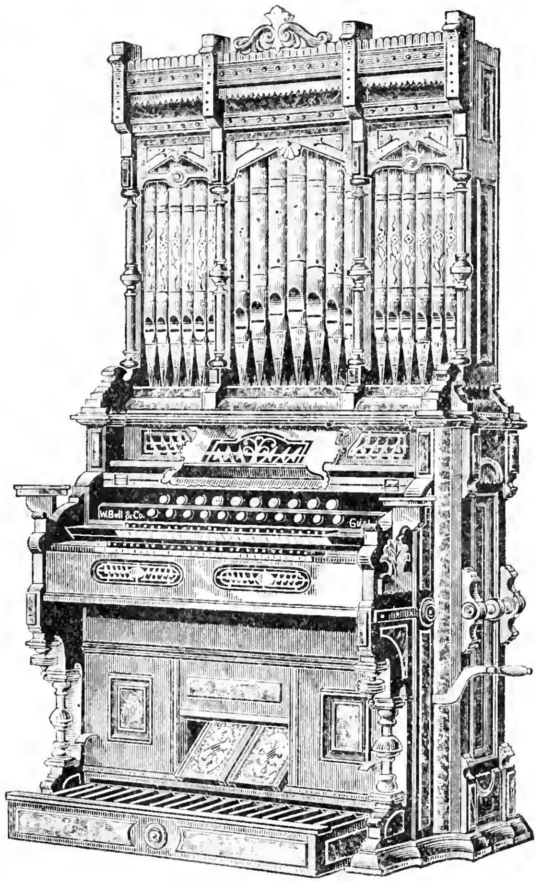

Fig. 26.—Improved Model, with Two Manuals and Pedals (capable of fine artistic effects).

The manufacture of reeds, keys, and many other parts of the instrument became specialized as in the case of the piano, but not to such an extent The Munroe Reed Company was the most important of these specialists, the others being largely associated with the kindred industry of piano-making.

Improvement in the organ since 1850 has been expressed in the development of tone and case structure, as remarked, while the chief patents taken out have been for mechanical contrivances to cheapen production. Modern parlor organs represent considerable intelligence and accumulated effort in their scope and character, many of the examples produced coming close to the smaller

pipe-organs in effect. Quality of tone, together with power and great variety, are now possible, whereas the harmoniums, melodeons, and seraphines known in 1860 were simple instruments with one set of reeds and no stops worthy of the name, being only fit for domestic hymn-singing. Notwithstanding, the organ has ceased to be popular at present, nearly all the firms named having added the production of pianos to their business. The latter instrument has been growing into popular favor, to the disadvantage of the former, and if present indications are reliable the production of organs will be an insignificant branch of industry in the future; yet some look forward to the re-establishment of the organ in popular favor.

Many attempts have been made to combine reeds with strings in the piano, the first being made by Prof. Wheatstone, in London, in 1834. Obed Coleman, a native of New Bedford, Mass., invented a system for uniting both in a square piano, which he named the Æolian attachment. This was adopted by a Boston manufacturer in 1844, but was abandoned after a few years. Other attempts have been made, with like results.

Organs combining the features of the pipe and reed have been also made, the Peloubet system being regarded as the most successful. Lyon & Healy, of Chicago, manufacture the "Peloubet reed-pipe organs" at present, their trade extending to Europe largely. Another form of organ somewhat approximate is the Vocalian. The physical basis of sound production in this instrument resembles that of the human voice, according to its inventor, Dr. Hamilton, a Scottish gentleman, who produced it after many years of study and experiment. The instrument consequently attracted much attention when introduced here in 1882. It comes very close to the pipe-organ in quality, and is an excellent substitute. Mason & Risch, of Worcester, Mass., manufacture these instruments.

Mechanical instruments called organettes are also produced in large numbers for export and domestic purposes. In these, sheets of perforated paper run over the reeds, the perforations admitting free play for the air, thus producing the desired effect. They are of American invention. Organs employing somewhat similar methods for the mechanical production of music by pneumatic action have come into use recently, but, while capable of yielding pleasing effects, they are decried by musicians, upon the ground that the individuality of an artistic musical performance can not be duplicated apart from human instrumentality. This is, however, only a matter of opinion. While the majority of organ manufacturers are scattered throughout various States—unlike the piano art industry, which is mostly concentrated in New York and Boston—Chicago is the largest producing center in the country.

MORAL EDUCABILITY.

By EDWARD PAYSON JACKSON.

FOR a long time the brain has been accepted, popularly as well as scientifically, as a gauge of intellectual capacity; less widely it has been known as an equally accurate gauge of physical and also of moral energy. If narrow compass and few and shallow convolutions in what are known as the intellectual "areas" infallibly indicate mental deficiency, the same conditions in the moral areas as infallibly indicate moral deficiency. It is a hard saying, but, whatever bearing it may have upon the doctrine of free moral agency and personal responsibility for action, it is as true as it is hard.

But there is a great difference in the results of feeble or arrested development in the three different sets of brain areas. Each case is attended with disadvantages peculiar to itself; only in the case of the moral areas are these disadvantages looked upon as "penalties." If the physical basis of intellect is ill developed, the subject may be doomed to obscurity, neglect, and perhaps hard manual labor for his livelihood; if the ganglia which supply his muscles and vital organs with nerve-force are small and weak, he must suffer life-long invalidism; in either case he is simply "unfortunate"; but if Nature has allowed him only an ill-developed physical basis for the moral faculties, his unhappy deficiency is visited with the abhorrence and indignation of his fellow-men; he is a criminal, and he must suffer the "just punishment of his misdeeds" in prison or on the gallows.

Whether these differences involve an element of injustice on the part of Nature or her controller, or on the part of man, is not our question. Suffice that they exist, and that they are, in a measure at least, inevitable, since society does not need to be protected from the mental or the physical imbecile as it does from the moral imbecile. Both justice and policy demand, however, that the chief motive and purpose of society in dealing with the moral imbecile should be self-protection rather than punishment for the sake of punishment. We do not slay mad dogs to punish them for the crime of rabies, but simply to prevent ourselves and others from being bitten.

The idea is gradually gaining strength that the most just as well as the most effective means of protection from the moral imbecile is moral education. If there is injustice involved in the fact that he was created a moral imbecile, then this is the most direct and obvious means of righting that wrong; if there is no such injustice, it still remains the best possible policy, both as regards society and the subject himself.

And, happily, of the three sets of brain areas, that which forms the physical basis of the moral faculties is by far the most capable of improvement by cultivation. It is the part which most quickly and fully responds to educative influences. And there is entire correspondence in the improved outward conduct, which may as truly be looked upon as the effect of increased brain-power as stronger muscular action is of more highly developed muscles.

History demonstrates the pre-eminent educability of the moral part of man. The ancient athlete did not differ essentially from his modern ectype. There is not much to choose intellectually between Cicero and Wendell Phillips, between Aristotle and Herbert Spencer, between Copernicus and Charles Darwin, between the prehistoric genius who first smelted iron ore and Edison. The intellectual status of the educated classes of ancient Rome did not differ materially from that of the corresponding classes of modern London or New York; but compare their moral status! The wealth, beauty, and fashion of Rome assembled in eager thousands to witness the entertaining spectacle of wholesale human butchery: we stigmatize a bull-fight as intolerable savagery, worthy only of belated Spain, Portugal, or Mexico, and even the blood and bruises of a prize-fight are too much for the humanity and self-respect of any but blacklegs, thieves, "sports," and of a few scions of royalty and other *quasi*-respectable men. The ancients punished not only their criminals but often their innocent captives with death by torture: imagine a populous city of our day, absorbed in its various employments and pleasures, unconcerned while in full sight on a neighboring plain men are for days together writhing and moaning out the inconceivable agonies of crucifixion! Not only would such a thing be impossible in our day, but we are actually divided in opinion as to whether painless death by electrocution is not too barbarous a way of disposing of criminals. The ancients immured their lunatics and idiots in noisome subterranean dungeons, and left their paupers, their halt, blind, and deaf to shift for themselves or to depend upon casual private benevolence: we build almshouses, hospitals, and asylums, and our best scientific skill is taxed to its utmost in behalf of our unfortunates of these classes.

Such are a few of the ways in which improvement in the average moral sentiment of humanity within the Christian era is shown. We wonder at the monstrous cruelties of past ages. How could they have been possible, we ask, since "human nature has always been the same"? But human nature has *not* always been the same; it has always been changing: it is changing now, and it will always continue to change. And the rate of improvement is continually accelerating. Those born since the war find

it difficult to comprehend the barbarities of even one short generation ago. Their children will find the barbarities of to-day equally incredible. The horrors of Siberia, of the Russian persecution of Israel, of the no less infamous sweat-shops in our own country, may relegate the latter third of the nineteenth century to the same limbo of infamy to which the ages of Nero and Simon Legree are condemned, notwithstanding the comparatively great ameliorations in the average condition of the human race. Still later generations will wonder at the possibility of inhumanity which in our day condemns the many to life-shortening and life-embittering toil that the few may consume in luxurious idleness the price of their sweat and suffering; at the travesty of justice which punishes the criminal who robs his one victim with his puny arm of flesh and bends the knee to the ruffian who despoils his thousands with his mightier brain: at the selfish greed of the titled idlers who partition the soil among themselves and take heavy toll of the multitude of Earth's children for presuming to live upon the bosom of their common mother; at the unspeakable cruelty of the sex which flatters and spoils with indulgence a portion of the other sex, and drives by its tyranny another portion to starvation, suicide, or infamy.

Thus the mists which becloud the moral perceptions of men and chill their nobler impulses will lift one after another, as generation succeeds generation. But not until the law of love shall have made civil laws with their penalties superfluous and obsolete, not until the universal enforcement of the golden rule, not by objective, but by subjective penalties, will the moral education of mankind be complete.

In his later work, on Leonardo da Vinci and the Alps, Prof. Gustavo Uzielli treats of certain passages in the great artist's manuscripts containing references to the Alps. Telling of his ascent of Monboso or Monte Rosa in the middle of July, Leonardo incidentally remarks that snow rarely falls on the summit, but only hail in the summer, when the clouds are highest; also, that the extreme darkness of the sky and the luminosity of the sun are accounted for by the less extent of atmosphere between the spectator and the sun than if he stood on the lower plains at the foot of the mountain. The fruits of Leonardo's observations of the Alps are to be found in his works as an artist, and particularly in his portrait of the Mona Lisa, whom he placed amid their snows. But he studied them also with a practical eye, with a view to the utilization of the water that flows down their sides to the plains of Lombardy. Operations in connection with this purpose required the personal examination of the formation of the mountains; and while on his excursions he studied their geology, the density of matter, the action of light, and the composition of the atmosphere. His attention was also occupied with botanical studies and observations of the flight of birds. And there is evidence that he looked at the mountains also with the eye of a military engineer.

THE AUSTRALIAN MARSUPIAL MOLE.

By Dr. E. TROUESSART.

THE discovery of a new mammal with distinct enough characteristics to constitute the type of a new family, possibly of an order, in the class of Didelphæ or Aplacentariæ, is, at this age, a zoölogical event of great importance. The discovery is still more interesting in the case of an animal presenting so curious a form and organization as the one about to be described. The account we give of it is taken from the original memoir of Mr. E. C. Stirling, Director of the South Australian Museum and professor in the University of Adelaide, who found the animal in the central desert of Australia. The researches of English naturalists, especially of the ornithologist Gould, have made us so well acquainted with the fauna of New Holland that the announcement of the existence in that country of a living mammal that fills what has long been recognized as a gap in it is a real surprise.

The *Notoryctes*, as Prof. Stirling has named it, is a marsupial mole presenting remarkable analogies at once with the *Chrysochlores*, or moles, of the Cape of Good Hope, placentary insectivores peculiar to South Africa, and with the primitive mammals of the Secondary period and the beginning of the Tertiary, of which only the dentition is known to us. The name, *Notoryctes typhlops*, means blind burrower of the South.

The first individual of this species, of which Prof. Stirling saw the remains in very bad condition, was captured in 1888 by Mr. Coulthard, a cattle-raiser of northern South Australia. Following the tracks of the animal, he found it at the foot of a tuft of porcupine-grass (*Spinifex* or *Triodia irritans*). Although he had lived many years in the country, he had never seen or heard of it before. The region where it was found is about a thousand miles north of Adelaide; is bounded on the northeast by the dry bed of Finke River, and is a country of dunes and red sand, with spots of vegetation composed exclusively of *Spinifex* and *Acacia*. It rarely rains there. The species does not seem to be very abundant, and the natives appeared to have no knowledge of the animal when a figure of it was shown them. Much interested in his discovery, Prof. Stirling visited the South Australian desert and procured six specimens of the Notoryctes, four female and two male, and preserved them in alcohol for dissection on his return to Adelaide.

It was only with the assistance of the natives, and their surprising gifts in following the tracks of an animal, that it was possible to procure the precious specimens. The rainy season of the short semitropical summer of the country is the most favorable time

for this kind of investigation. The tracks of the animal are then preserved in the ground, while the soil is at other times too friable to retain any mark. The Notoryctes is essentially a burrower, and never comes out from under the sand except to run a few feet in a slow and tortuous gait, dragging its belly along the ground. It walks, clinching the outer edges of its claws in the ground, leaving a triple, often interrupted, sinuous track, the lateral lines of which are drawn by the feet, the middle line by the tail, on which the animal supports itself by beating it on the ground. The track resembles those of some Australian lizards, which Prof. Stirling was apt at first to mistake for them.

The Notoryctes burrows obliquely in the sand, going two or three inches under the ground, and never betraying its passage except by a slight undulation of the soil. In digging it uses its conical nose, which is protected by a horny plate, and the strong, mattock-shaped claws of its fore feet. The hind feet, which are wider and spade-shaped, throw the sand back so that no trace is left of the tunnel which it hollows. It comes to the surface a few yards farther on, and then buries itself again, all without making any noise. It is prodigiously agile and swift, a property on which Mr. Benham, who lived for some time at Idracowra, says: "Everybody here can tell you how soon one of these animals will get away by digging in the sand. I had brought a live one to the house and we were talking of its agility in digging. Mr. Stokes desired to see it at work. After spading and turning over the ground near the house, we set the animal down; I held it in my hands till it was nearly hidden, and then tried to overtake it by scratching the ground behind it, but it was quicker than I. I took a shovel and tried to find it, but without success. Another man came to my help with a second shovel, and also a native woman used to digging in the ground with her hands. But all three of us could not find it."

The Notoryctes are hard to keep alive, even if large tubs full of sand are provided. Night and day can be heard the slight sound they make in digging in this friable soil. They would not touch the ants which Mr. Stirling gave them, although ants were found in their stomachs. On the other hand, they readily ate the large white grubs of long-horned beetles and Lepidoptera; one of them even ate bread, but it died the next day. They did not try to bite when taken in the hand. The natives call them *oor-quamata*, and seem to have a superstitious fear of them, arising perhaps from the animal's being almost unknown. They have never seen the young ones. The intestines of different individuals dissected by Mr. Stirling contained ants and other insects.

At first sight, the animal looks very much like the *Chrysochlores*, or golden moles of the Cape, but differs from them by

its strong tail (the Chrysochlores have none), in the shape of its incisors, and in the presence of a pouch in the female. It is smaller than the European mole. Its pelage is yellowish, golden at some points, and silvered at others. It has no distinct neck, but the cheeks merge into the shouders. It results that the body

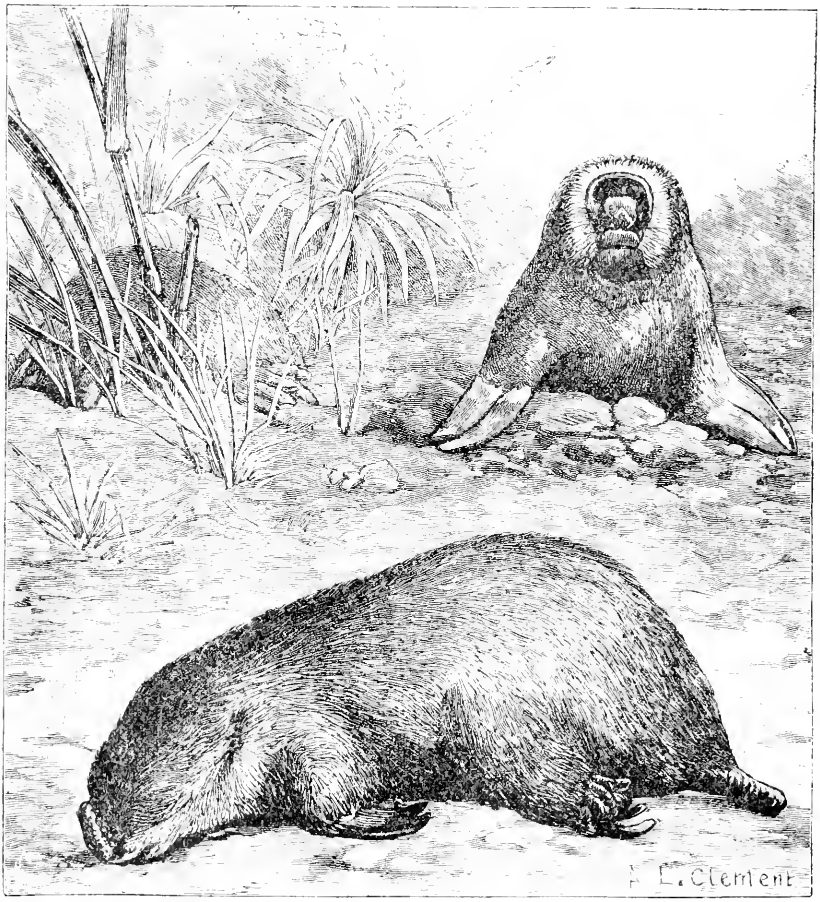

Fig. 1.—The New Mammal, Notoryctes typhlops (slightly reduced).

is strongly arched. The nose, the feet, and the tail only are in the same plane. The nostrils are pierced through the horny plate which protects the muzzle, and which is divided in two by a transversal furrow. The mouth is underneath. The tongue is broad and shaped like a man's tongue.

There are no outside traces of eyes. Those organs are not even indicated by a pigmentary spot visible under the skin. The external ear is represented by a small roundish hole. The tail is singular, having the form of a truncated cone; is bare, ringed,

hidden to a considerable extent by the hairs of the back, but fully visible from below. It is swelled out near the middle by two considerable lateral tuberosities. The fore feet are similar to those of the Chrysochlores. The two large arched and compressed nails of the third and fourth digits conceal the others, with the exception of the obtuse and corneous nail of the fifth digit, which is turned back and inserted at the base of the fourth. On examining the narrow palm of this paw, we can discover the thin, atrophied nails of the thumb and second finger. The palm is cleft, and the fingers form two groups: the outer, consisting of the third, fourth, and fifth; and the inner, of the first and second. The hind paws are likewise short and very thick, more robust than those of the Chrysochlores, spade-shaped, have the sole turned outward, are deeply grooved, and bare to the metatarsus.* The first four toes are subequal; the fifth is represented by a short nail, much like that of the hand, and flanked by a large, broad, and flat sesamoid bone. The tibia is thick.

The dentition of the Notoryctes comprises forty teeth—ten in each branch of the jaws. The molars resemble those of the Chry-

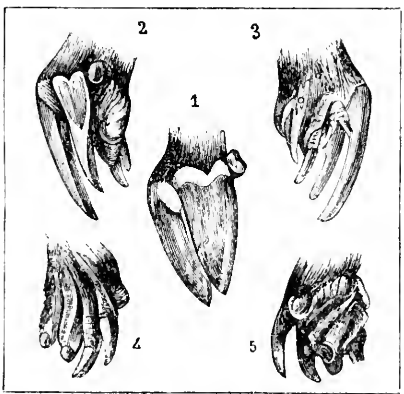

FIG. 2.—FEET OF THE NOTORYCTES. 1, 2, and 3, fore foot seen in front, in profile, and from beneath; 4 and 5, hind foot, from above and from beneath.

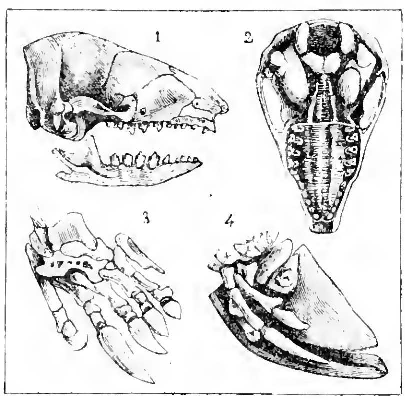

FIG. 3.—DETAILS OF THE SKELETON (enlarged). 1 and 2, skull, profile and from beneath; 3 and 4, feet.

sochlores, having, like them, V-formed crowns; but the front teeth, especially the incisors, are much smaller than those of the Chrysochlores. This fact is remarkable, considering that the general form of the skull is also strikingly like that of the Chrysochlores. The median incisors are, like those of the *Musaraignes* and most of the placentary insectivores, *scalpriformed*, or thick and hooked like the teeth of rodents, and constitute strong organs of prehension which touch on the median line. On the other

* From an examination of the osteology, we should say that the hind feet of the Notoryctes are similar in form to the fore feet of the real moles.

hand, the front teeth of the Notoryctes are small, hardly more than pegs, and leave a considerable gap on the median line, a disposition like that observed in some of the edentates. It might be well to compare this dentition with that of the *Myrmecobia*, which is also Australian, and with that of some of the types of Eocene fossil mammals which have recently been discovered in

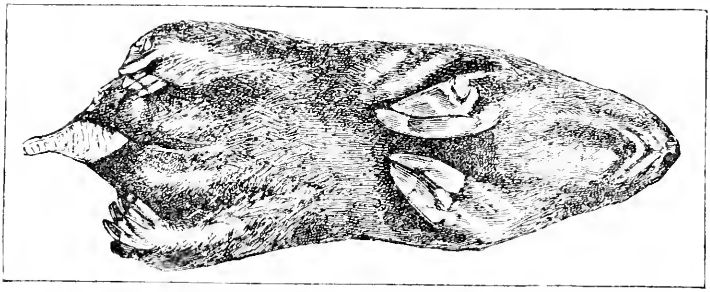

Fig. 4.—Notoryctes. (View of the under side; two thirds the natural size.)

South America. The angular apophysis of the lower jaw is markedly bent within, a tolerably constant characteristic of the opossums. The marsupial bones, on the other hand, are but little developed. They are represented only by two small osseous nodules diverging forward and united in the tendon of the oblique external muscle of the abdomen at its insertion on the symphysis of the pubis. They are hardly visible with the lens, and might easily pass undetected in a hasty or superficial dissection. Nothing is yet known of the method of reproduction of the Notoryctes.

As a whole, we are struck by the resemblances exhibited between the Notoryctes and the African Chrysochlores; the forms of the skull, of the molar teeth, and of the fore limb are such as to lead us to suppose something more than a simple secondary adaptation depending on an identical mode of life. The unlikeness, on the contrary, between the incisors and the canine teeth of the two types is deserving of closer study. It is of interest to recollect that these two genera are not the only ones which establish by their outer forms a bond of relationship between the South African and the Australian fauna. The *Pedetes* (*Helamy*), or great jerboa of the Cape, exhibits absolutely the forms of the Australian kangaroos, although it is a placentary rodent. There are also well-known relations between the South African and the Australian flora.—*Translated for The Popular Science Monthly from La Nature.*

[Mr. J. Douglas Ogilby has reached the conclusion, after a careful study of Mr. Stirling's accounts of this animal, that in it we have at last obtained a definite connecting link between the Monotremes (*Ornithorhyncus*) and the Marsupials (kangaroos and opossums). At the present state of our knowledge it would, he thinks, be presumptuous to class Notoryctes among the Monotremes proper, although several naturalists incline to the opinion that its affinities are closer to those animals than to the Marsupials.—Ed. P. S. M.]

JUSTUS VON LIEBIG:

AN AUTOBIOGRAPHICAL SKETCH.*

MY father, who had a color warehouse, frequently occupied himself in making some of the colors in which he dealt, and for that purpose had fitted up for himself a small laboratory to which I had access, and where I sometimes enjoyed the privilege of helping him. He made his experiments as prescribed in works upon chemistry, which were, with great liberality, lent to the inhabitants of Darmstadt from the rich Court Library.

The lively interest which I took in my father's labors naturally led me to read the books which guided him in his experiments, and such a passion for these books was gradually developed in me that I became indifferent to every other thing that ordinarily attracts children. Since I did not fail to fetch the books from the Court Library myself, I became acquainted with the librarian Hess, who occupied himself successfully with botany, and as he took a fancy to the little fellow, I got, through him, all the books I could desire for my own use. Of course, the reading of books went on without any system. I read the books just as they stood upon the shelves, whether from below upward or from right to left was all the same to me; my fourteen-year-old head was like an ostrich stomach for their contents, and among them I found side by side upon the shelves the thirty-two volumes of Macquer's

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* Read at a joint meeting of societies in the Chemical Laboratories, University College, Liverpool, on Wednesday evening, March 18, 1891, by Prof. J. Campbell Brown, D. Sc.

[At the recent celebration of the Jubilee of the Chemical Society, reference was made to the wonderful energy and ability of Liebig, to the great work which he did in founding organic chemistry, and to the immense stimulus which he gave, alike in his own country and in England, to scientific investigation in pure chemistry and in its applications to agriculture, physiology, and pathology.

Very opportunely a portion of an autobiographical sketch in Liebig's own handwriting has just come to light, in which he gives a most interesting account of the formation of his habits of thought, and of the development of his scientific activity. He also gives an amusing description of the lectures given in his student days by professors of the deductive method.

In his sixtieth year, we are told, Liebig wrote some biographical sketches which were laid aside and could not be found when he wished to resume them. They were never finished. A portion of the manuscript was found among some other papers in Liebig's handwriting by his son Dr. Georg Baron von Liebig, and has been published by the latter in the *Deutsche Rundschau* for January, 1891. Mr. E. K. Muspratt has been good enough to lend me a copy which he received from his friend the present baron.

I have endeavored to render it into English as literally as the difference in the idiom and modes of expression in the two languages will permit; and it is now made public in England by the kind permission of the *Deutsche Rundschau*.

His method of teaching and its remarkable success are worthy of attention at the present time, when technical education is occupying so much of the public mind.]

Chemical Dictionary, Basil Valentine's Triumphal Car of Antimony, Stahl's Phlogistic Chemistry—thousands of essays and treatises in Göttling's and Gehlen's periodicals, the works of Kirwan, Cavendish, etc.

I am quite sure that this manner of reading was of no particular use so far as acquisition of exact knowledge is concerned, but it developed in me the faculty, which is peculiar to chemists more than to other natural philosophers, of thinking in terms of phenomena; it is not very easy to give a clear idea of phenomena to any one who can not recall in his imagination a mental picture of what he sees and hears, like the poet and artist for example. Most closely akin is the peculiar power of the musician, who, while composing, thinks in tones which are as much connected by laws as the logically arranged conceptions in a conclusion or series of conclusions. There is in the chemist a form of thought by which all ideas become visible to the mind as the strains of an imagined piece of music. This form of thought is developed in Faraday in the highest degree, whence it arises that to one who is not acquainted with this method of thinking, his scientific works seem barren and dry, and merely a series of researches strung together, while his oral discourse, when he teaches or explains, is intellectual, elegant, and of wonderful clearness.

The faculty of thinking in phenomena can only be cultivated if the mind is constantly trained, and this was effected in my case by my endeavoring to perform, so far as my means would allow me, all the experiments whose description I read in the books. These means were very limited, and hence it arose that, in order to satisfy my inclination, I repeated such experiments as I was able to make a countless number of times, until I ceased to see anything new in the process, or till I knew thoroughly every aspect of the phenomenon which presented itself. The natural consequence of this was the development of a memory of the sense, that is to say of the sight, a clear perception of the resemblances or differences of things or of phenomena, which afterward stood me in good stead.

One will easily understand this if one imagines, for instance, a white or colored precipitate which is produced by mixing two liquids; it is formed either at once or after some time, it is cloudy or of a curdy or gelatinous character, sandy or crystalline, dull or bright, it deposits easily or slowly, etc.; or if it is colored it has a certain tint. Among the countless white precipitates each has something peculiar to itself; and when one has experience in this sort of appearances, whatever one sees during an investigation at once awakens the remembrance of what one has seen. The following example will make clear what I mean by sight or eye memory: During our joint research on uric acid, Wöhler one

day sent me a crystalline body which he had obtained by the action of peroxide of lead upon this acid: I immediately thereupon wrote to him with great joy, and without having analyzed the body, that it was allantoin. Seven years before I had had this body in my hands; it had been sent to me by C. Gmelin for investigation, and I had published an analysis of it in Poggendorf's *Annalen;* since that time I had not seen it again. But when we had analyzed the substance obtained from uric acid there appeared a difference in the amount of carbon, the new body gave one and a half per cent carbon less, and since the nitrogen had been determined by the qualitative method a corresponding quantity (four per cent) of nitrogen more; consequently it could not possibly be allantoin. However, I trusted my eye-memory more than my analysis, and was quite sure that it was allantoin, and the thing now to be done was to find the remains of the substance previously analyzed in order to analyze it afresh. I could describe the little glass in which it was with such precision that my assistant at last succeeded in picking it out from among a couple of thousand other preparations. It looked exactly like our new body, except that examination under the lens showed that Gmelin, in the preparation of his allantoin, had purified it with animal charcoal, some of which having passed through the paper in the filtration had become mixed with the crystals.

Without the complete conviction which I had that the two bodies were identical, the allantoin produced artificially from uric acid would undoubtedly have been regarded as a new body, and would have been designated by a new name, and one of the most interesting relations of uric acid to one of the constituents of the urine of the fœtus of the cow would perhaps have remained for a long time unobserved. In this manner it came to pass that everything I saw remained intentionally or unintentionally fixed in my memory with equal photographic fidelity. At a neighboring soap-boiler's I saw the process of boiling soap, and learned what "curd soap" and "fitting" are, and how white soap is made; and I had no little pleasure when I succeeded in showing a piece of soap of my own making, perfumed with oil of turpentine. In the workshop of the tanner and dyer, the smith and brass-founder, I was at home, and ready to do any hand's turn.

In the market at Darmstadt I watched how a peripatetic dealer in odds and ends made fulminating silver for his pea-crackers. I observed the red vapors which were formed when he dissolved his silver, and that he added to it nitric acid, and then a liquid which smelt of brandy, and with which he cleaned dirty coat-collars for the people. With this bent of mind it is easy to understand that my position at school was very deplorable; I had no ear-memory and retained nothing or very little of what is learned through this

sense; I found myself in the most uncomfortable position in which a boy could possibly be; languages and everything that is acquired by their means, that gains praise and honor in the school, were out of my reach; and when the venerable rector of the gymnasium (Zimmermann), on one occasion of his examination of my class, came to me and made a most cutting remonstrance with me for my want of diligence, how I was the plague of my teachers and the sorrow of my parents, and what did I think was to become of me, and when I answered him that I would be a chemist, the whole school and the good old man himself broke into an uncontrollable fit of laughter, for no one at the time had any idea that chemistry was a thing that could be studied.

Since the ordinary career of a gymnasium student was not open to me, my father took me to an apothecary at Heppenheim in the Hessian Bergstrasse; but at the end of ten months he was so tired of me that he sent me home again to my father. I wished to be a chemist, but not a druggist. The ten months sufficed to make me completely acquainted alike with the use and the manifold applications of the thousand and one different things which are found in a druggist's shop.

Left to myself in this way, without advice and direction, I completed my sixteenth year, and my persistent importunity at last induced my father to give me permission to go to the University of Bonn; whence I followed to Erlangen the Professor of Chemistry, Kastner, who had been called to the Bavarian University. There arose at that time at the newly established University of Bonn an extraordinary quickening of scientific life; but the degenerate philosophical methods of investigation, as they had been embodied in Oken, and still worse in Wilbrand, had a most pernicious influence on the branches of natural science, for it had led alike in lecture and in study to a want of appreciation of experiment and of an unprejudiced observation of Nature, which was ruinous to many talented young men.

From the professional chair the pupil received an abundance of ingenious contemplations; but, bodiless as they were, nothing could be made of them. The lectures of Kastner, who was considered a most eminent chemist, were without order, illogical, and arranged just like the jumble of knowledge which I carried about in my head. The relations which he discovered between phenomena were somewhat after the following pattern:

"The influence of the moon upon the rain is clear, for as soon as the moon is visible the thunderstorm ceases," or "the influence of the sun's rays on water is shown by the rise of the water in the shafts of mines, some of which can not be worked in the height of summer." That we see the moon when the thunderstorm is dispelled, and that the water rises in the mine when the brooks

which drive the pumps dry up in summer, was, of course, too blunt an explanation for a clever lecture.

It was then a very wretched time for chemistry in Germany. At most of the universities there was no special chair for chemistry; it was generally handed over to the professor of medicine, who taught it, as much as he knew of it, and that was little enough, along with the branches of toxicology, pharmacology, materia medica, practical medicine, and pharmacy. Many years after this in Giessen, descriptive and comparative anatomy, physiology, zoölogy, natural history, and botany were in one single hand.

While the labors of the great Swedish chemist, the English and French natural philosophers, Humphry Davy, Wollaston, Biot, Arago, Fresnel, Thenard, and Dulong, opened up entirely new spheres of investigation, all these inestimable acquisitions found no soil in Germany where they could bear fruit. Long years of war had undermined the well-being of the people, and external political pressure had brought in its train the desolation of our universities, filled men with painful anxiety for many years, and turned their desires and their strength in other directions. The national spirit had asserted its freedom and independence in ideal spheres, and by the destruction of belief in authority had brought rich blessings in many ways—for example, in medicine and philosophy; only in physiology it had broken through its natural limits, and wandered far beyond experience.

The goal of science and the fact that it has value only when it is useful to life had almost dropped out of sight, and men amused themselves in an ideal world which had no connection with the real one. It was considered an almost debasing sentiment, and one unworthy of an educated person, to believe that in the body of a living being the crude and vulgar inorganic forces played any part. Life and all its manifestations and conditions were perfectly clear. Natural phenomena were clothed in bewitchingly lovely dress, cut out and fitted by clever men, and this was called philosophical investigation. Experimental instruction in chemistry was all but extinct at the universities, and only the highly educated pharmacists, Klaproth, Hermbstädt, Valentin Rose, Trommsdorff, and Buchholz, had themselves preserved it, but in another department.

I remember, at a much later period, Prof. Wurzer, who held the chair of chemistry at Marburg, showing me a wooden table drawer, which had the property of producing quicksilver every three months. He possessed an apparatus which mainly consisted of a long clay pipe-stem, with which he converted oxygen into nitrogen by making the porous pipe-stem red hot in charcoal, and passing oxygen through it.

Chemical laboratories, in which instruction in chemical anal-

ysis was imparted, existed nowhere at that time. What passed by that name were more like kitchens filled with all sorts of furnaces and utensils for the carrying out of metallurgical or pharmaceutical processes. No one really understood how to teach it. I afterward followed Kastner to Erlangen, where he had promised to analyze some minerals with me; but unfortunately he did not himself know how to do it, and he never carried out a single analysis with me.

The benefit which I gained through intercourse with other students during my sojourn in Bonn and Erlangen was the discovery of my ignorance in very many subjects which they brought with them from school to the university, and since I got nothing to do in chemistry I laid out all my energies to make up for my previously neglected school studies. In Bonn and Erlangen small numbers of students joined with me in a chemico-physical union, in which every member in turn had to read a paper on the question of the day, which, of course, consisted merely in a report on the subjects of the essays which appeared monthly in Gilbert and Schweigger's *Journal.*

In Erlangen, Schelling's lectures attracted me for a time, but Schelling possessed no thorough knowledge in the province of natural science, and the dressing up of natural phenomena with analogies and in images, which was called exposition, did not suit me. I returned to Darmstadt fully persuaded that I could not attain my ends in Germany.

The dissertations of Berzelius—that is to say, the better translation of his handbook, which had a large circulation at that time—were as springs in the desert. Mitscherlich, H. Rose, Wöhler, and Magnus had then repaired to Berzelius, in Stockholm; but Paris offered me means of instruction in many other branches of natural science, as, for instance, physics, such as could be found united in no other place. I made up my mind to go to Paris. I was then seventeen and a half years old. My journey to Paris, the way and manner in which I came in contact with Thenard, Humboldt, Dulong, and with Gay-Lussac, and how the boy found favor in the sight of those men, borders on the fabulous, and would be out of place here. Since then it has frequently been my experience that marked talent awakens in all men, I believe I may say without exception, an irrepressible desire to bring about its development. Each helps in his own way, and all together as if they were acting in concert; but talent only compels success if it is united with a firm, indomitable will. External hindrances to its development are in most cases very much less than those which lie in men themselves; for just as no one of the forces of Nature, however mighty it may be, ever produces an effect by itself alone, but always only in conjunction with other forces; so

a man can only make valuable that which he learns without trouble, or acquires readily, for which, as we say, he has a natural gift, if he learns many other things in addition, which perhaps cost him more trouble to acquire than other people.

Lessing says that talent really is *will and work*, and I am very much inclined to agree with him.

The lectures of Gay-Lussac, Thenard, Dulong, etc., in the Sorbonne, had for me an indescribable charm; the introduction of astronomical or mathematical method into chemistry, which changes every problem when possible into an equation, and assumes in every uniform sequence of two phenomena a quite certain connection of cause and effect, which, after it has been searched for and discovered, is called "explanation" or "theory," had led the French chemists and physicists to their great discoveries. This kind of "theory" or "explanation" was as good as unknown in Germany, for by these expressions was understood not something "experienced," but always something which man must add on and which he fabricates.

French exposition has, through the genius of the language, a logical clearness in the treatment of scientific subjects very difficult of attainment in other languages, whereby Thenard and Gay-Lussac acquired a mastery in experimental demonstration. The lecture consisted of a judiciously arranged succession of phenomena—that is to say, of experiments whose connection was completed by oral explanations. The experiments were a real delight to me, for they spoke to me in a language I understood, and they united with the lecture in giving definite connection to the mass of shapeless facts which lay mixed up in my head without order or arrangement. The antiphlogistic or French chemistry had, it is true, brought the history of chemistry before Lavoisier to the guillotine; but one observed that the knife only fell on the shadow, and I was much more familiar with the phlogistic writings of Cavendish, Watt, Priestley, Kirwan, Black, Scheele, and Bergmann, than with the antiphlogistic; and what was represented in the Paris lectures as new and original facts appeared to me to be in the closest relation to previous facts, so much so, indeed, that when the latter were imagined away the others could not be.

I recognized, or more correctly perhaps the consciousness dawned upon me, that a connection in accordance with fixed laws exists not only between two or three, but between all chemical phenomena in the mineral, vegetable, and animal kingdoms; that no one stands alone, but each being always linked with another, and this again with another, and so on, all are connected with each other, and that the genesis and disappearance of things is an undulatory motion in an orbit.

What impressed me most in the French lectures was their

intrinsic truth, and the careful avoidance of all pretense in the explanations; it was the most complete contrast to the German lectures, in which the whole scientific teaching had lost its solid construction through the preponderance of the deductive method.

An accidental occurrence drew A. von Humboldt's attention to me in Paris, and the interest which he took in me induced Gay-Lussac to complete, in conjunction with me, a piece of work which I had begun. In this manner I had the good fortune to enjoy the closest intercourse with the great natural philosopher; he worked with me as he had formerly worked with Thenard; and I can well say that the foundation of all my later work and of my whole course was laid in his laboratory in the arsenal.

I returned to Germany, where through the school of Berzelius, H. Rose, Mitscherlich, Magnus, and Wöhler, a great revolution in inorganic chemistry had already commenced. Through the support of von Humboldt's warm recommendation, an extraordinary professorship of chemistry at Giessen was conferred upon me in my twenty-first year.

My career in Giessen commenced in May, 1824. I always recall with pleasure the twenty-eight years which I spent there: it was as if Providence had led me to the little university. At a larger university or in a larger place my energies would have been divided and dissipated, and it would have been much more difficult, and perhaps impossible, to reach the goal at which I aimed; but at Giessen everything was concentrated in work, and in this I took passionate pleasure. The need for an institution in which the students could be instructed in the art of chemistry, by which I mean familiarity with chemical analytical operations, and skill in the use of apparatus, was then being felt; and hence it happened that, on the opening of my laboratory for teaching analytical chemistry and the methods of chemical research, students by degrees streamed to it from all sides. As the numbers increased I had the greatest difficulty with the practical teaching itself. In order to teach a large number at one time it was necessary to have a systematic plan, or step-by-step method, which had first to be thought out and put to the proof. The manuals which several of my pupils have published later (Fresenius and Will) contain essentially, with little deviation, the course which was followed at Giessen; it is now familiar in almost every laboratory.

The production of chemical preparations was an object to which I paid very particular attention; it is very much more important than is usually believed, and one can more frequently find men who can make very good analyses than such as are in a position to produce a pure preparation in the most judicious way. The formation of a preparation is an art, and at the same time a

qualitative analysis, and there is no other way of making one's self acquainted with the various chemical properties of a body than by first producing it out of the raw material, and then converting it into its numerous compounds and so becoming acquainted with them.

By ordinary analysis one does not learn by experience what an important means of separation crystallization is in skillful hands; and just as little the value of an acquaintance with the peculiarities of different solvents. Consider only an extract of a plant or of flesh which contains half a dozen crystalline bodies in very small quantities imbedded in extraneous matter, which almost entirely masks the properties of the others; and yet, in this magma, we can recognize by means of chemical reactions the peculiarities of every single body in the mixed mass, and learn to distinguish what is a product of decomposition and what is not, in order to be able to separate them afterward by means which will exert no decomposing influence. An example of the great difficulty of finding the right way in such researches is afforded by the analysis of bile by Berzelius. Of all the numerous substances which he has described as its constituents no one is, properly speaking, contained in the natural bile.

An extremely short time had been sufficient for the famous pupils of the Swedish master to give a wonderful degree of perfection to mineral analysis, which depends on an accurate knowledge of the properties of inorganic bodies; their compounds and their behavior to each other were studied in all directions by the Swedish school with a keenness quite unusual previously and even now unsurpassed. Physical chemistry, which investigates the uniform relations between physical properties and chemical composition, had already gained a firm foundation by the discoveries of Gay-Lussac and von Humboldt on the combining proportions of bodies in the gaseous state, and those of Mitscherlich on the relations between crystalline form and chemical composition; and in chemical proportions the structure appeared to have received its coping-stones and to stand forth completed. All that foreign countries had acquired in by-gone times in the way of discoveries now yielded rich fruit also in Germany.

Organic chemistry—or what is now called organic chemistry—had then no existence. It is true that Thenard and Gay-Lussac, Berzelius, Prout, and Döbereiner, had already laid the foundations of organic analysis, but even the great investigations of Chevreul upon the fatty bodies excited but little attention for many years. Inorganic chemistry demanded too much attention, and, in fact, monopolized the best energies.

The bent which I acquired in Paris was in a quite different direction. Through the work which Gay-Lussac had done with

me upon fulminating silver I was familiar with organic analysis, and I very soon saw that all progress in organic chemistry depended essentially upon its simplification; for in this branch of chemistry one has to do not with different elements which can be recognized by their peculiar properties, but always with the same elements whose relative proportions and arrangement determine the properties of organic compounds. In organic chemistry an analysis is necessary to do that for which a reaction suffices in inorganic chemistry. The first years of my career in Giessen I devoted almost exclusively to the improvement of the methods of organic analysis, and the immediate result was that there began at this little university an activity which had never before been seen.

For the solution of innumerable questions connected with plants and animals, on their constituents, and on the reactions accompanying their transformation in the organism, a kindly fate brought together the most talented young men from all the countries of Europe, and any one can imagine what an abundance of facts and experiences I gained from so many thousands of experiments and analyses, which were carried out every year, and for so many years, by twenty and more indefatigable and skilled young chemists.

Actual teaching in the laboratory, of which practiced assistants took charge, was only for the beginners; the progress of my special students depended on themselves. I gave the task and supervised the carrying out of it; as the radii of a circle have all their common center. There was no actual instruction; I received from each individual every morning a report upon what he had done on the previous day, as well as his views on what he was engaged upon. I approved or made my criticisms. Every one was obliged to follow his own course. In the association and constant intercourse with each other, and by each participating in the work of all, every one learned from the others. Twice a week, in winter, I gave a sort of review of the most important questions of the day; it was mainly a report on my own and their work combined with the researches of other chemists.

We worked from break of day till nightfall. Dissipations and amusements were not to be had at Giessen. The only complaint, which was continually repeated, was that of the attendant (Aubel), who could not get the workers out of the laboratory in the evening, when he wanted to clean it. The remembrance of this sojourn at Giessen awakened in most of my pupils, as I have frequently heard, an agreeable sense of satisfaction for well-spent time.

I had the great good fortune, from the commencement of my career at Giessen, to gain a friend of similar tastes and similar aims, with whom, after so many years, I am still knit in the bonds

of warmest affection. While in me the predominating inclination was to seek out the points of resemblance in the behavior of bodies or their compounds, he possessed an unparalleled faculty of perceiving their differences. A keenness of observation was combined in him with an artistic dexterity, and an ingeniousness in discovering new means and methods of research or analysis such as few men possess. The achievement of our joint work upon uric acid and oil of bitter almonds has frequently been praised; it was his work. I can not sufficiently highly estimate the advantage which the association with Wöhler brought to me in the attainment of my own as well as our mutual aims, for by that association were united the peculiarities of two schools—the good that was in each became effective by co-operation. Without envy and without jealousy, hand in hand, we pursued our way; when the one needed help the other was ready. Some idea of this relationship will be obtained if I mention that many of our smaller pieces of work which bear our joint names were done by one alone; they were charming little gifts which one presented to the other.

After sixteen years of the most laborious activity I collected the results gained, so far as they related to plants and animals, in my Chemistry applied to Agriculture and Physiology, two years later in my Animal Chemistry, and the researches made in other directions in my Chemical Letters. The last-mentioned was generally received as a popular work, which, to those who study it more closely, it really is not, or was not at the time when it appeared. Mistakes were made, not in the facts, but in the deductions about organic reactions; we were the first pioneers in unknown regions, and the difficulties in the way of keeping on the right path were sometimes insuperable. Now, when the paths of research are beaten roads, it is a much easier matter; but all the wonderful discoveries which recent times have brought forth were then our own dreams, whose realization we surely and without doubt anticipated.

Here the manuscript ends, and it is to be hoped that more of it will yet be found.

Liebig's reference to Wöhler is very touching, and shows a side of his character which all his pupils knew well; they tell many genial stories illustrating his unselfishness and kindness of heart. One could have wished that he had not considered the stories "bordering on the fabulous," of how he "found favor in the sight of Humboldt, Gay-Lussac, and Thenard, out of place here." They would have been far from out of place. Mr. Muspratt supplies one of these stories as he heard it from Liebig's own lips, in the Munich Laboratory, as follows:

Liebig frequently spoke in most grateful terms of the kind manner in which he—a youth barely eighteen—was received by Gay-Lussac, Thenard, and other eminent chemists, in Paris.

In the summer of 1823 he gave an account of his analysis of fulminating silver before the Academy. Having finished his paper, as he was packing up his preparations, a gentleman came up to him and questioned him as to his studies and future plans, and, after a most exacting examination, ended by asking him to dinner on the following Sunday. Liebig accepted the invitation, but, through nervousness and confusion, forgot to ask the name and address of his interviewer. Sunday came, and poor Liebig was in despair at not being able to keep his engagement.

The next day a friend came to him and said, "What on earth did you mean by not coming to dine with von Humboldt yesterday, who had invited Gay-Lussac and other chemists to meet you?" "I was thunderstruck," said Liebig, "and rushed off, as fast as I could run, to von Humboldt's lodgings, and made the best excuses I could." The great traveler, satisfied with the explanation, told him it was unfortunate, as he had several members of the Academy at his house to meet him, but thought he could make it all right if he would come to dinner next Sunday. He went, and there made the acquaintance of Gay-Lussac, who was so struck with the genius and enthusiasm of the youth that he took him into his private laboratory, and continued, in conjunction with him, the investigation of the fulminating compounds.—*Chemical News.*

THE COTTON INDUSTRY IN BRAZIL.

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COTTON is indigenous to Brazil. The oldest documents relating to that country contain many references to its existence there and to the uses made of it by the Indians at the time of the discovery. There is no indication, however, that it was then cultivated to any considerable extent by the natives. The picture of the indifference of the aborigines in regard to such matters is vividly suggested by the manner in which a few straggling plants are allowed to grow, even nowadays, about the houses of the civilized Indians, and by the poor classes generally throughout the interior of the country.

As soon, however, as the Portuguese came to Brazil, bringing with them a knowledge of the cultivation of cotton and of its uses, there was established an industry which has been an important factor in the material prosperity and development of the country. Although by the end of the seventeenth century cotton was quite generally cultivated throughout Brazil, it was used almost exclusively for domestic purposes until the last half of the

eighteenth century. The earliest record of its exportation is given incidentally in the story of the shipwreck of Jorge de Albuquerque Coelho, who sailed from Pernambuco in May, 1565. The passage was a stormy one, and the sea became so rough at one time that they were obliged to throw part of their cargo overboard. "And seeing that all this was of no avail, and that the waves grew the higher, as if they wished to overwhelm us, we threw overboard the artillery and many boxes of sugar, and many bales of cotton."

Early Uses.—In early times—indeed, as late as 1747—cotton thread and cotton cloth were used throughout Brazil in lieu of money. In 1670 it was complained that, unless the exportation of cotton cloth was prohibited, "not a yard of cloth, or rather no money, would be found in Maranhão." Balls of cotton thread were used as small change, and circulated as such in all the shops and in all kinds of financial transactions. The manufacturers of these balls do not appear to have been always scrupulously honest, for the Legislature was finally obliged to take action to prevent the fraud of putting pieces of cloth, rags, and other such things in them. The trade in cotton between the neighboring captaincies became so large that the authorities of Maranhão, in order to keep all the money at home, prohibited the exportation of cotton from that place, and it was not until fifty years later (1756) that this law was repealed.

The manufacture of cotton cloth was carried on to such an extent ("the people generally, even the senators, were accustomed to dress in clothing made of cotton") that complaint was made to the King of Portugal by the Portuguese merchants that it was interfering with their export trade with the colony and with the receipts of the royal treasury. Instructions were, therefore, given (January 5, 1785) to the agents of the crown in Rio de Janeiro to prohibit all spinning-factories, and, if necessary, to confiscate the looms. This prohibition, however, did not extend to the factories and looms for making coarse cotton cloth, such as was used for clothing slaves and for like purposes.

Yet in the face of these obstacles cotton culture in Brazil rapidly increased. The only statistics to be obtained of the exportation of cotton up to the end of the eighteenth century are those of the captaincy or province of Maranhão. In 1760 Maranhão exported 24,960 pounds of cotton; and in 1800, 5,529,408 pounds. That captaincy, however, stood only second among those exporting cotton; Pernambuco exported more than twice as much as Maranhão, while Bahia, Rio de Janeiro, and Pará together exported about as much as Maranhão. Cotton was also one of the principal products of Rio Negro, Piauhy, Rio Grande do Norte, Parahyba, Alagôas, and Sergipe. These facts give us an idea of

the extent of cotton culture in Brazil at the end of the eighteenth century.

When, at the beginning of the nineteenth century, the royal family of Portugal came to Brazil, it ceased to be a mere colony; the empire was established, and a new impetus was given to all industries. The ports were made free to friendly foreign powers, and the decree prohibiting the use of looms was revoked.

THE COTTON REGION.—The territory in Brazil capable of yielding cotton is coextensive with the country itself. From São Paulo all along the coast to the Amazon, and, for that matter, throughout the entire country, cotton might be grown in almost unlimited quantities. In reality, however, it is only cultivated to any considerable extent in the drier regions of the north, and along the valley of the Rio São Francisco, and in some parts of the province of Minas Geraes.

In the north—i. e., to the north of Sergipe—a belt along the coast about fifty miles wide is, for the most part, devoted to the production of sugar. Immediately beyond this is the region in which cotton is actually grown, the width of which region depends almost solely upon the distance which the producers feel themselves able to transport it.

As cotton culture, replaced by the cultivation of sugar, has receded from the coast, the question of transportation has become a very serious one with Brazilian planters. Roads are usually so poor and markets so far away that the planters necessarily lose the greater part of their profits in the expense of transportation. The remedy generally recommended is railways; but railways, where they already exist, have not in all cases been found a remedy for this state of affairs. Cotton sent by rail from the interior of the province of São Paulo to the seaboard at Santos pays out in freight about thirteen per cent of its value. The planters of Pernambuco pay out from twenty-five to thirty per cent of the value of their cotton in freights. Along the large streams, where it is possible to ship cotton by water, it can be moved with some facility. As a rule, however, transportation is on horseback or muleback, and it is thus brought to market often for a distance of from three hundred to four hundred miles, trips sometimes requiring three or four months for a troop of mules, over roads that are nothing more than bridle-paths, and often very bad ones at that.

VARIETIES CULTIVATED.—It is not to be supposed that only native varieties of cotton are cultivated in Brazil. Indeed, the three varieties best known to and used by Brazilian planters are all exotic. The *crioulo* is a large bush from five to fifteen feet in height, is very hardy, and, if properly cared for, will last two or

three years. The smooth, black seeds of the *crioulo* * cling so firmly to each other that they separate only when pressed very strongly between the fingers, and the fiber can be stripped from them without their being separated and without leaving any lint upon them. The cotton, when ripe, clings firmly and compactly within the boll, and it is for this reason more difficult to pick.

The variety known as the *quebradinho* is distinguished from the preceding by having seeds which readily separate from each other. The seeds are fewer in number and the bolls smaller than in the *crioulo*. Both of these varieties, and the yellow variety mentioned below, are known as "tree cotton." One occasionally hears of tree cotton lasting from five to ten years; but, while this may be literally true, the crops borne by these old plants are hardly worth the picking.

The herbaceous variety (called *herbaceo*) is an annual plant, growing from three to five feet high, and is identical with that generally cultivated in the United States. The seeds separate in the bolls, and the ripe cotton hangs from them in large flocks. This species produces more fiber, sometimes from five to six times as much as either of the preceding kinds, but the quality is considered much inferior. The yield on a given piece of ground of the herbaceous cotton is four times as large as that of tree cotton, and in picking one can gather twice as much from the herbaceous in a given time. Herbaceous cotton is said to have been introduced from the United States, and there is no doubt about its having been taken to Brazil within a comparatively short period.

The only other variety deserving attention is the yellow or light brown, which, however, is not grown in any considerable quantities, owing undoubtedly to its color and to its small yield of fiber. The color is not generally considered an attractive one, but it is valued for certain household articles, such as hammocks, in which neutral tints and fast colors are desirable.

CULTIVATION.—Substantially the same system of cultivation is used to-day that was in vogue three hundred years ago. Auguste de Saint-Hilare wrote in 1812, "All the planter has to do is to burn off the woods and plant his seed at the proper season." This is the whole story. There is no uprooting of stumps, no digging out of sprouts, no breaking up with the plow, no preparation of the soil, no laying out of furrows, no cultivation other than the occasional chopping out with the hoe of weeds or sprouts.

Rotation of crops is almost entirely unknown. Fields are seldom laid out with any definite forms, as they would be if the

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* This variety takes its name from the black color of the seeds, the word *crioulo* being sometimes applied to negroes in Brazil.

plow were in common use, but vary in shape to suit the convenience of the planters, who adapt themselves to the natural features of the surface and character of the soil. If the place to be planted is forest, whether heavy or of only a few years' growth, the laborers, with bill-hooks for the undergrowth and axes for the trees, begin clearing it from one side, felling the trees and undergrowth toward the open space, and leaving stumps of any height that may make the work of clearing easier. No effort is made to pile the brush in heaps. This work is done in the dry season, and the brush is allowed to lie for several months, until the approach of the rainy season, when the whole, being thoroughly dried by long exposure to the rays of a very hot sun, is set on fire. The want of arrangement of the branches permits the burning of all the leaves and of the small limbs, twigs, etc., but the larger branches and the trunks of the fallen trees are only blackened by the passing fire. A more desolate sight than one of these "new grounds" can not be imagined. Sometimes a few of the half-burned pieces are piled together and set on fire, but usually they are allowed to lie where they happen to have fallen. The soil is now ready for the seed. The laborers go over the field with large, heavy hoes, and with powerful blows open holes to receive the seeds at intervals more or less irregular. The cotton seeds are planted in these holes, and with the foot or hand covered with a little earth. The spaces between the hills are generally supposed to be from five to eight palms, according to the fertility of the soil. Sometimes rows are attempted in a rude, rambling way, and in such cases the hills are about six palms apart in one direction and eight in the other, according as the stumps and logs and half-consumed limbs may permit.

The planting season varies in different localities according to the time when the rains generally set in. Most of it is done in the months of February and March, though planting-time may vary a month or two either way, according to the season and the nature of the ground, low, rich soil generally being planted later than the dry uplands. Difference is also made with the kind of cotton, the tree cotton generally being planted a month or two earlier than the herbaceous. Sometimes other things are planted between the rows of cotton, such as beans, rice, or corn.

Shortly after the planting the season of rains sets in ,and cotton, weeds, sprouts, and all come up and grow with a vigor and rapidity only to be seen in the tropics. When the cotton is about to be choked out by useless vegetation, the hoes are sent to chop it out—an operation that is performed two or three times, or as often as circumstances are supposed to require it, during the year. The amount of cleaning required by a field depends upon the richness of the soil and upon the length and character of the win-

ter or wet season, rich soil and long, wet winters producing more weeds and requiring more attention. So far as tillage is concerned, this chopping out of the weeds and sprouts is the nearest approximation to cultivation the plants receive, and the soil naturally becomes as hard as a brick.

INSECTS.—While Brazil is the home of the cotton plant, it is at the same time the home of insects affecting that plant. Besides the "cotton-worm" (*Aletia argellacea*), which occurs in that country at times in vast swarms very much as it does in the Southern States, there are other moths whose larvæ attack the cotton in a similar manner. The "boll-worm" (*Heliothis armigera*) is also a native of Brazil, and occasionally does great injury to the cotton crop. But, while these insects exist in Brazil under climatic conditions more favorable to their multiplication than are those of the United States, these favorable circumstances are offset very materially by the vast number of insect enemies which these same climatic conditions foster. As a rule, the Brazilian planter feels himself utterly at the mercy of Fate when the "cotton-worms" attack his crop. No remedies for the evil are known, and none are ever attempted. They seem to think that to combat the plague would be to "fly in the face of Providence"; that when God wishes it stopped he'll send rains and stop it himself. The percentage of loss through these insects varies greatly, but I have known of many instances of a loss of fifty per cent of the crop. Such a loss, however, is unusually large for that country.

PICKING.—Cotton-picking does not assume the importance in Brazil that it does in the Southern United States. Fields are never large, and picking is done more at the leisure and convenience of the planter. With the varieties of tree cotton there is but little risk of loss in leaving the ripe cotton in the bolls longer than could be done with the herbaceous variety, for the seeds of the former, being more compact when they ripen, do not cause the fiber to thrust the mass in a loose flock from the boll, as is the case with the latter. The cotton-pickers carry baskets or bags with them, in which the cotton is placed as it is gathered, very much as is the custom in this country.

GINNING.—What kind of a gin to use has been a question of importance among Brazilian planters. The question was not between the various kinds of saw-gins, but between saw-gins and the old-fashioned way of cleaning cotton with two small wooden cylinders revolving close to each other.

The roller-gin is simply two short wooden cylinders, less than an inch in diameter, geared together and revolved close to each other after the fashion of a modern clothes-wringer. The raw cotton is fed slowly between the cylinders, and the seeds are removed by being pinched from the cotton and thrust back on the side from

which it is fed. This machine is objectionable on account of the slowness with which it operates, and also on account of its often crushing the seeds and thus soiling the staple.

The saw-gin was introduced into Brazil during the civil war in the United States, when it was necessary to put into the market at once a large supply of cotton. The saw-gin is said to break the fiber of the cotton much more than the roller-gin, and for that reason many efforts have been made by the English spinners to suppress it. But in spite of these efforts the saw-gin remains master of the situation, and nowadays it is but rarely that any other kind is seen in Brazil, even in the remote interior. In every community in which cotton is grown there is at least one gin, the proprietor of which buys the unginned cotton from the planters and small farmers, cleans and bales it, and sends it to market. No use is now made of the cotton seeds. They are usually thrown out as so much waste. The cattle are allowed to eat what they choose, and sometimes they are used for fuel.

Home Consumption.—Owing to the ease with which cotton is produced, the extent of its culture, the difficulty of getting the raw material into market from remote points, the evenness and mildness of the temperature, which, as a rule, does not require the warmer clothing of a more rigorous climate, the number of domestic purposes for which it is used, and the high tariff upon foreign manufactured goods, the home consumption of cotton is very large, and has steadily increased. In consequence of the decree prohibiting the use of looms, the cotton consumed in the country, until the beginning of the present century, was manufactured in the most aboriginal manner. About 1845 cotton factories began to spring up, and there are now no less than fifty spinning and weaving establishments in Brazil.

The manufacturing industry is at present confined almost wholly to the provinces of Rio de Janeiro, Minas Geraes, São Paulo, and Bahia, where the demand for the better grades of cotton cloth is greatest. But the factories have by no means done away with direct domestic consumption of raw material. To the traveler in the interior of Brazil there is no more familiar sight than that of spinning with the ancient distaff and spindle. In some parts of the country this custom is so common that the children learn it as a matter of course, and it would be very difficult to find a person who did not know how to spin. In order to show the wide-spread knowledge of this art in the interior, a Brazilian gentleman once assured me that it might be taken for granted that the then Brazilian prime minister could spin cotton in this aboriginal fashion. Very nearly all the hammocks used throughout the northern part of Brazil, together with considerable quantities of coarse cloth, are still made of thread spun in this manner. The

direct domestic consumption is about 1,162,000 pounds annually, which, with the amount made up by the factories and used in the country, makes the whole consumption of raw material in Brazil 18,481,600 pounds annually since the factories began operation.

PRODUCTION.—The total export from the whole empire from 1851 to 1876, inclusive, was 1,695,304,075 pounds. Add 27,900,000 pounds for the direct domestic consumption for the same period, and 69,276,400 pounds for the amount used by the factories during the four years from 1872 to 1876, and we have as the production of cotton by the whole empire, during the twenty-four years from 1851 to 1876, an average of 74,686,700 pounds per annum, or about twice as much as that of the State of Arkansas.

During the civil war in the United States, the exportation of cotton from Brazil assumed proportions hitherto unknown to that country. From the year 1850 to 1861 the average annual amount of cotton exported was 28,300,000 pounds. The exports rapidly increased from 21,400,000 in 1861 to 102,600,000 in 1868. As the United States recovered from the effects of the war, the amount of cotton exported from Brazil, although still large and fluctuating from year to year, was gradually decreasing, until in 1876 the exportation had fallen to 63,609,000 pounds. An impetus, however, was given to cotton culture in Brazil by the civil war in the United States which has been of great permanent benefit to the industry in that country.

Cotton in Brazil grows on its native soil, and, it is to be presumed, under climatic and other conditions best adapted to its highest development. But, though Brazil began to export cotton more than a hundred years before the United States, her annual product to-day is only about one eighteenth as much as our own. To be sure, the population is only one fifth as large as ours, but there almost the whole population lives in a cotton-growing region, while only a small part of our people live in the cotton belt.

Under normal conditions Brazil can scarcely become a competitor of the United States in cotton production; but the disappearance of slavery and the consequent adoption of some system of small farming will, in the near future, materially increase the present production. Slavery has fostered a remarkable conservatism in agriculture, which must, with the aid of educated planters, soon disappear. Cotton-factories are already rapidly springing up and prospering, and the day is not far distant when they will supply the Brazilian market.

The same agricultural tools and methods now employed by the average planters were in use more than two hundred years ago—methods learned from their Portuguese ancestors and from their African slaves. It is far from my intention, however, to criticise

these methods or the men who use them. The climate in which they live and the circumstances which have produced and retained these methods are so entirely different from our climate and our surroundings that any criticism from our standpoint would almost necessarily be unjust. The lack of capital and the lack of common roads are serious matters, no doubt, but they are not insuperable difficulties. Insect plagues that destroy from a fourth to a half of their crops are great drawbacks, but such questions should be regarded, not as visitations of God, before which man is powerless, but as practical matters to be met and dealt with as our planters are meeting and dealing with similar plagues in this country.

DARWINISM IN THE NURSERY.

By LOUIS ROBINSON, M. D.

WITHIN quite recent times we have learned that such seemingly trivial things as nursery rhymes and fairy tales are of the greatest importance in illustrating some points of the history and affinities of the human race, and also, in a less degree, in indicating the character of the ideas of our early ancestors concerning the forces and phenomena of Nature.

The value of the intense conservatism of the nursery in thus preserving for us, in an almost unchanged form (like ants in the resin of the Tertiary epoch or mammoths in the frozen tundra of the Quaternary), relics of the thoughts and customs of long ago has only begun to be appreciated; and doubtless if the nursery were less of a close preserve to the poachers and priers of science, and, like the beehive and the ant-hill, were available for purposes of investigation or experiment, we might considerably add to our knowledge concerning the history and habits of primitive man. At present there is a gap between embryology and anthropology which has never been filled up; and, oddly enough, with one or two exceptions, there have been hitherto no attempts to make use of the abundant material close at hand for the purpose of filling it. In this essay I propose to bring forward a few results of researches that have been carried out during several years under rather unusually favorable circumstances, in the hope that in some humble degree I may contribute to this end.

Some of the results obtained have been extraordinary, and the hesitation with which they have been received by some of my friends well versed in physiology and anthropology shows that hitherto the facts have escaped attention. They are, however, easily verified, and in several instances a single experiment performed in presence of a skeptic has cut short the controversy in a

satisfactory manner. Many of the inferences drawn are no doubt much more open to question, and they are here put forward chiefly with the purpose of drawing the attention of those much better able to judge of the value and bearing of the facts than the present writer.

It is curious how little has been written on the natural history of the human infant in its normal state. We have, of course, an abundant medical literature on the ailments and care of young children, but the many eminent physicians who have written on the subject have confined their attention almost entirely to abnormal or diseased conditions. Even in studying the healthy physiological processes the primary idea has been to gain the kind of knowledge which would be available in the treatment of disease rather than that which might illustrate the history of the development of the race, and this may easily account for many facts of very considerable value for the latter purpose being overlooked or not appreciated at their proper value.

It is plain that a typically healthy infant, in which Nature's processes go on without the interference of medical art, will, after the first crisis of its entry on an independent existence is over, scarcely come under the notice of the physician at all.

The three classes of persons who are brought into close enough contact with the objects under discussion to study their habits and characteristics are medical men, nurses, and parents. The first have been already dealt with. Of the second class we may say that their knowledge, although doubtless profound, and derived both from tradition and observation, does not seem very available for the purposes of science. This has hitherto been my experience, for although in nearly every case where questions were asked there was every assumption and appearance of superior erudition, yet it seemed almost impossible to tap the supply.

Parents, as a rule, from the very nature of their relationship to their offspring, are obviously unable to look on them with the cold, impartial gaze of the scientific investigator. At any rate, experience has proved that very little has resulted from their observations. The parental bias must, more or less, vitiate results; and the average mother, in spite of many unquestioned merits, is about as competent to take an unprejudiced view of the facts bearing on the natural history of her infant as a West African negro would do to carry out an investigation of the anatomy and physiology of a fetich.

There are some illustrious exceptions, and Darwin himself, in his Expression of the Emotions and Descent of Man, gives an account of some very interesting observations on several of his own children when infants. Several salient traits seem, however, to have completely escaped him, and some of these, which will be

dealt with in this paper, have a most important bearing on the argument on which he was then laying most stress, viz., that man is descended from an arboreal quadrumanous ancestor. The fact that such important and easily ascertained characteristics as those alluded to should have been passed over by one so keenly observant of all phenomena bearing upon his theory might suggest that the great man was scarcely so supreme in his own nursery as he was in the wider field of research, and that his opportunities for investigation were to some extent limited by the arbitrary and inflexible rules of this household department. In fact, the supposed interest of the Darwinian race, when conflicting with the interests of the Darwinian theory, appear to have become paramount somewhat to the detriment of the latter.

It has been well said that the development of the individual from the single germ-cell to maturity is an epitome of the infinitely longer development of the race from the simplest form of life to its present condition. No branch of science, not even paleontology, has thrown so much light on the evolution theory as the study of the structure and progress of the embryo up to the time of birth. There seems, however, no reason why embryology should stop here. An animal until independent of parental care, and even beyond that point, until the bodily structures and functions are those of an adult, is still, strictly speaking, an embryo; and we may learn much of its racial history by observing the peculiarities of its anatomy and habits of life.

For instance, among our domestic animals, horses and cattle live very much in the same manner, and thrive equally well grazing in open pastures. Yet a brief examination of the young of each shows that the habits and habitats of their respective wild ancestors were widely different. A foal from birth is conspicuous for the development of its legs, and when a few days old can gallop almost as fast as ever it will in its life. It makes no attempt at concealment beyond retiring behind its dam, and it carries its head high, evidently on the alert to see danger and flee from it. A young calf, on the contrary, is not much longer in the leg in proportion than its parents (I exclude, of course, the breeds artificially produced within quite recent times), and has but an indifferent turn of speed, and it is slow and stupid in noticing its surroundings. It has, however, one powerful and efficient instinct of self-preservation; for if, as is often the case in a bushy pasture, the mother leaves it under cover while she goes to graze, it will lie as still as death, and allow itself to be trodden on rather than betray its hiding-place. Hence we see that the ancestors of our domestic horses inhabited open plains where there was little or no cover, and that they escaped by quickly observing the approach of a foe and by speed. Wild cattle, on the contrary, as is still

seen in some parts of Texas and Australia, never from choice stray far from the shelter of the woods; and their ancestors, when threatened, lay couched among the bushes like deer, in the hope of escaping observation. It is very remarkable how quickly horses and cattle, though domesticated for thousands of generations, during which long period many of their wild instincts and habits have been entirely in abeyance, regain all the old power of self-preservation proper to the wild state, and often in a single generation become as acute in powers of scent and vision, and other means of escaping from their enemies, as animals which have never been tamed. There are at present probably no animals so alert and difficult to approach as the "brumbies," of Australia. In no way could more eloquently be shown the immense stretch of time during which these qualities were formed and became ingrained in the very nature and structure of their possessors than by comparing them with the trivial and evanescent effects of many centuries of domestication.

In the case of our own race it has often been observed that schoolboys present many points of resemblance to savages both in their methods of thinking—especially about abstract subjects—and in their actions. Younger children without a doubt also reflect some of the traits of their remote progenitors. If, as in the case of the calf and the foal, we look for traces of habits of self-preservation that for incalculably long periods were most necessary for the safety of the individual (and therefore for the preservation of the race), we shall find that such habits exist, and are impossible to explain on any other hypothesis than that they were once of essential service.

Take, for instance, the shyness of very young children and their evident terror and distress at the approach of a stranger. At first sight it seems quite unaccountable that an infant a few months old, who has experienced nothing but the utmost kindness and tender care from every human being that it has seen, should cling to its nurse and show every sign of alarm when some person new to it approaches. Infants vary much in this respect, and the habit is not by any means universal, though it is far more often present than absent. This would suggest that, whatever its origin, it was not for any very long period (in the evolutionary sense) absolutely necessary to preserve the species from extinction. Darwin merely alludes to the shyness of children as probably a remnant of a habit common to all wild creatures. We need not, however, go back to any remote ancestral form to find a state of affairs in which it might prove of the greatest service. We know that the cave-dwellers of the Dordogne Valley were cannibals, and that much later, when the races that piled together the Danish "kitchen middens" lived on the shores of the Baltic and German

Oceans, they were very much such savages as the present inhabitants of Tierra del Fuego, and lived after the same fashion. Like the Fuegians, they were probably divided into small clans, each of a few families, and these, from conflicting interests and other causes, would be constantly at war. The earlier palæolithic savages, living in caves and rock shelters, would be even more isolated and uncompromising in their treatment of strangers, for the game of any given district would only be sufficient to support a few. If in our day

> "Lands intersected by a narrow frith
> Abhor each other, mountains interposed
> Make enemies of nations,"

in the time of palæolithic and early neolithic man every district the size of an English parish would be the hunting-ground of a clan, with fierce enemies on every side. In such a state of affairs a stranger (unless he were safely tied to a stake) would be a most undesirable person in proximity to the wigwam and the picaninnies.

If he paid a call it would very likely be—in the scarcity of other game—with the purpose of carrying off a tender foe for table use. Under such circumstances the child who ran to its mother, or fled into the dark recesses of the cave, upon first spying an intruder would be more likely to survive than another of a more confiding disposition. Often, during the absence of the men on a hunting expedition, a raid would be made, and all the women and children that could be caught carried away or killed. The returning warriors would find their homes desolate, and only those members of their families surviving who, by chance or their own action, had escaped the eyes of the spoilers. On the approach of an enemy—and "stranger" and "enemy" would be synonymous—the child which first ran or crawled to its mother, so that she could catch it up and dash out of the wigwam and seek the cover of the woods, might be the only one of all the family to survive and leave offspring. Naturally the instinct which caused the child to turn from the stranger to the mother would be perpetuated; and from the frequency of the habit at the present day it seems probable that many of our ancestors were so saved from destruction. We must remember that the state of society in which such occurrences would be frequent lasted many thousand years, and that probably scarcely a generation was exempt from this particular and unpleasant form of influence.

When we bear in mind that the play of young animals is almost always mimic war, it is well worthy of note how very early young children will take to the game of "hide and seek." I have seen a child of a year old who, with scarcely any teaching, would

hide behind the curtains and pretend to be in great alarm when discovered. Probably the readiness with which infants play at "bo-peep," and peer round the edge of a cradle curtain, and then suddenly draw back into hiding, is traceable to a much earlier ancestor. Here we see the remains of a habit common to nearly all arboreal animals, and the cradle curtain, or chair, or what not, is merely a substitute for a part of the trunk of a tree behind which the body is supposed to be hidden, while the eyes, and as little else as possible, are exposed for a moment to scrutinize a possible enemy and then quickly withdrawn.

It is remarkable how quickly very young children notice and learn to distinguish different domestic animals. I have known several cases in which an infant under a year old, which could not talk at all, has recognized and imitated the cries of sheep, cows, dogs, and cats, and evidently knew a horse from an ox. Not infrequently I have heard great surprise expressed by parents at the quickness with which a baby would perceive some animal a long distance off, or when from other causes it was so inconspicuous as to escape the eyes of older persons. Pictures of animals, too, have a great fascination, and the child is never tired of hearing its playmate roar like a lion or bray like an ass when looking at them in the picture-book. This may seem of trivial import; but it is worth while to remember that the baby's forefathers for several thousand generations depended upon their knowledge of the forms and ways of wild beasts in order to escape destruction, either from starvation or from being overcome and devoured in contests with them; and that any and every individual who was a dunce at this kind of learning was in a short time eliminated. Hence an aptness to notice and gain a knowledge of different animals was essential to those who wished to survive, and a faculty so necessary, and so constantly operative through long ages, would be likely to leave traces in after-generations.

Among all arboreal apes the ability firmly to hold on to the branches is, of course, extremely important, and in consequence they have developed a strong power of grip in the hands. The late Frank Buckland compares the hands of an anthropoid ape to grapnels, from their evident adaptation to this end. Nor does this power exist only among adults, for although most apes, when at rest, nurse their young on one arm, just as does a mother of our own species, when, as often happens, they are fleeing from an enemy, such as a leopard or some other tree-climbing carnivorous animal, the mother would need all her hands to pass from branch to branch with sufficient celerity to escape. Under such circumstances the infant ape must cling on to its mother as best it can; and naturalists who have repeatedly seen a troop of monkeys in full flight state that the young ones as a rule hang beneath the

necks and breasts of the mothers, holding on by the long hair of their shoulders and sides. This was the case with a young Rhœsus monkey born in the Zoölogical Gardens. Wallace, in his Malay Archipelago, gives an account of a very young orang which he secured after shooting the mother. He states that the baby orang was in most points as helpless as a human infant, and lay on its back, quite unable to sit upright. It had, however, an extraordinary power of grip, and when it had once secured a hold of his beard he was not able to free himself without help. On his taking it home to his house in Sarawak he found that it was very unhappy unless it could seize and hold on to something, and would lie on its back and sprawl about with its limbs until this could be accomplished. He first gave it some bars of wood to hold on to, but, finding it preferred something hairy, he rolled up a buffalo-skin, and for a while the little creature was content to cling to this, until, by trying to make it perform other maternal duties and fill an empty stomach, the poor orphan mias nearly choked itself with mouthfuls of hair and had to be deprived of its comforter. The whole story of this poor little ape is both amusing and pathetic, as well as instructive, and I can not do better than refer those not already acquainted with it to the book, which is as a whole as good an introduction for the young student to the science of evolution as could well be found.

This power to hold on to the parent in any emergency may be compared to the galloping power of the young foal and the instinct of concealment in the calf; it is the one chief means of self-preservation adopted by the young of the arboreal quadrumana. During long epochs, impossible to measure by years, it would constantly be exercised; and it is plain that every infant ape that failed to exercise it, or which was physically unable from any cause to cling to its mother, when pursued by an agile foe, would either fall to the ground or be devoured among the branches. When we consider the harassed and precarious life of all wild creatures and the number of their enemies, it becomes apparent that scarcely an individual would be exempt from being many times put to the test, and the habit would, by the survival of those only which were able to maintain their grip, become more and more confirmed, until it became an integral part of the nature of all quadrumana and their descendants.

This being so, it occurred to me to investigate the powers of grip in young infants; for if no such power were present, or if the grasp of the hands proved only to be equally proportionate to any other exhibition of muscular strength in those feeble folk, it would either indicate that our connection with quadrumana was of the slightest and most remote description, or that man had some other origin than the Darwinian philosophy maintains.

In The Luck of Roaring Camp every one will remember the expression of one of Bret Harte's mining ruffians after he had passed through the shanty containing the newly born "Luck" and the corpse of the wretched mother. "He wrastled with my finger," said Mr. Kentuck, regarding that member with curiosity, and characteristically adding some adjectives more emphatic than to the point. On reading the story aloud in company several years ago a discussion arose as to whether the novelist was as correct an observer of infant human nature as he doubtless was of the vagaries of the pious cut-throats and chaste courtesans of the Pacific slope in the golden days of '49, and considerable doubt was thrown on the statement of Mr. Kentuck, since it did not seem probable that so gelatinous and flabby a creature as a new-born babe could "wrastle" (and prevail) even with a finger. Subsequent observation proved that the novelist here did not go beyond Nature's warrant, and that, whatever doubts we may have of the disinterestedness of Mr. Oakhurst, or the constancy of "Miggles," "The Luck" was drawn true to type.

Finding myself placed in a position in which material was abundant, and available for reasonable experiment, I commenced a series of systematic observations with the purpose of finding out what proportion of young infants had a noticeable power of grip, and what was the extent of the power. I have now records of upward of sixty cases in which the children were under a month old, and in at least half of these the experiment was tried within an hour of birth. The results as given below are, as I have already indicated, both curious and unexpected.

In every instance, with only two exceptions, the child was able to hang on to the finger or a small stick three quarters of an inch in diameter by its hands, like an acrobat from a horizontal bar, and *sustain the whole weight of its body* for at least ten seconds. In twelve cases, in infants under an hour old, half a minute passed before the grasp relaxed, and in three or four nearly a minute. When about four days old I found that the strength had increased, and that nearly all, when tried at this age, could sustain their weight for half a minute. At about a fortnight or three weeks after birth the faculty appeared to have maintained its maximum, for several at this period succeeded in hanging for over a minute and a half, two for just over two minutes, and one infant of three weeks old for *two minutes thirty-five seconds!* As, however, in a well-nourished child there is usually a rapid accumulation of fat after the first fortnight, the apparently diminished strength subsequently may result partly from the increased disproportion of the weight of the body and the muscular strength of the arms, and partly from the neglect to cultivate this curious endowment. In one instance, in which the performer had less than one hour's

experience of life, he hung by both hands to my forefinger for ten seconds, and then deliberately let go with his right hand (as if to seek a better hold) and maintained his position for five seconds more by the left hand only. A curious point is, that in many cases no sign of distress is evinced, and no cry uttered, until the grasp begins to give way. In order to satisfy some skeptical friends I had a series of photographs taken of infants clinging to a finger or to a walking-stick, and these show the position adopted excellently. Invariably the thighs are bent nearly at right angles to the body, and in no case did the lower limbs hang down and take the attitude of the erect position. This attitude and the disproportionately large development of the arms compared with the legs, give the photographs a striking resemblance to a well-known picture of the celebrated chimpanzee "Sally" at the Zoölogical Gardens. Of this flexed position of the thighs, so characteristic of young babies, and of the small size of the lower extremities as compared with the upper, I must speak further later on; for it appears to me that the explanation hitherto given by physiologists of these peculiarities is not altogether satisfactory.

I think it will be acknowledged that the remarkable strength shown in the flexor muscles of the forearm in these young infants, especially when compared with the flaccid and feeble state of the muscular system generally, is a sufficiently striking phenomenon to provoke inquiry as to its cause and origin. The fact that a three-weeks-old baby can perform a feat of muscular strength that would tax the powers of many a healthy adult—if any of my readers doubt this let them try hanging by their hands from a horizontal bar for three minutes—is enough to set one wondering.

So noteworthy and so exceptional a measure of strength in this set of muscles, and at the same time one so constantly present in all individuals, must either be of some great utility now, or must in the past have proved of material aid in the battle for existence. Now it is evident that to human infants this gift of grip is of no use at all, unless indeed they were subjected to a severe form of an old south of England custom, which ordered that the babe, when three days old, should be lightly tossed on to the slope of a newly thatched roof, that it might, by holding on to the straw with its little hands, or by rolling helplessly back into the arms of its father, assist in forecasting its future disposition and prospects in life. Barring the successful passing of this ordeal—with regard to which I have never heard that non-success was a preliminary to immediate extinction—it seems plain that this faculty of sustaining the whole weight by the strength of the grasp of the fingers is totally unnecessary, and serves no purpose whatever in the newly born offspring of savage or civil-

ized man. It follows therefore that, as is the case with many vestigial structures and useless habits, we must look back into the remote past to account for its initiation and subsequent confirmation; and whatever views we may hold as to man's origin, we find among the arboreal quadrumana, and among these only, a condition of affairs in which not only could the faculty have originated, but in which the need of it was imperative, since its absence meant certain and speedy death.

It is a well-known fact that the human embryo about three months before birth has a thick covering of soft hair, called "lanugo," which is shed before a separate existence is entered upon. At the same stage of development the skeleton is found to conform much more to the simian type than later, for the long bone of the arm, the humerus, is equal to the thigh-bone, and the ulna is quite as long and as important as the tibia. At the time of birth the lower limbs are found to have gained considerably on the upper, but still they are nothing like so much larger as when fully grown. Physiologists have explained this want of development of the lower extremities in the fœtus by attributing it to the peculiarity of the ante-natal circulation, in which the head and arms are supplied with comparatively pure oxygenated blood fresh from the maternal placenta, and the lower part of the trunk and legs get the venous vitiated blood returned through the great veins and transferred *via* the right ventricle and the *ductus arteriosus* to the descending aorta. This, it is said, accounts for the more rapid growth and more complete development of the head and arms before birth. To assert the exact contrary would be to contradict several great authorities, and apparently to follow the lead of the pious sage who admired the wisdom and goodness of Providence in causing large rivers to flow by great cities. Nevertheless it is well to remember that just as the Sabbath was made for man, and not man for the Sabbath, so the blood-vessels were made for the body and not the body for the blood-vessels. It appears to me much more true to say that the quick arterial blood is sent to the upper extremities because these parts are for the time being more important, and their growth and development essential to the welfare of the individual, than that they are coerced into a kind of temporary hypertrophy, *nolens volens*, through having a better blood-supply arbitrarily sent them than is allotted to their nether fellow-members. That this view is borne out by facts can be shown by taking the example of a young animal whose hind quarters are of essential service to it from birth; and for this end we need go no further than the instance, already quoted, of the young foal. Now, in the ante-natal state the foal has just the same arrangement of blood-distribution as the embryo man; yet he is born with a small light head and well-developed hind quarters, so

that he can gallop with speed. Instead of coming into the world with the general outline of an American bison (as he ought to do upon accepted physiological dicta), he is, as is well known, proportionately higher at the rump and lower at the shoulder than in after-life. The mention of the American bison reminds me that it is another capital illustration of the same fact; for a young buffalo calf must have speed from its earliest days to enable it to keep up with the herd on the open prairie; and, in consequence, we find that it is much better developed behind (the hind legs being the chief propellers in all galloping animals) than the full-grown bull or cow, and has none of the comma-like, whittled-off aspect of its adult parents. The massive fore end of the bull bison arises from his habit of using himself as a projectile wherewith to batter his rivals out of the overlordship of the herd; but the bison calf is almost as level-backed as the young of our domestic cattle—though it is a much more active, wide-awake little beast than an ordinary calf.

Why, then, are the head and upper extremities so apparently abnormally developed in the young infant? I conceive the true reason to be something like this: For untold ages the perfection of the arms was a *sine qua non* of the continuance of the race; and as man, or the thing which was to be man, took to living by his wits—when, that is, *mind* began to take precedence of brute force and direct reflex action in the forefront of the struggle for existence—it became an absolute necessity for the being that was to live by his wits to be furnished with an abundant supply of the raw material out of which wits are made—that is, brains. Now, every man, actual or *in posse*—having elected, be it remembered, to fight chiefly with his brains, and having renounced forever the more gross and carnal weapons, such as huge canine teeth and heavy, claw-armed limbs—would be certainly bested in the struggle, and driven out of being, if his chosen armature were not up to the mark. In other words, every incipient *homo* who was born with deficient mind-material lived but a short time and left no offspring. And, since the potentialities of the brain depend far more upon its primary degree of development than do, for instance, the potentialities of the muscles, only those infants which were born with crania capacious and well-furnished would attain that degree of excellence which would prevent them from being fatally plucked in Nature's great perennial competitive examination. Only those infants, then, survived and became our ancestors which had from the first a good development of head and arm, and, to insure this, Nature has provided for a suitable blood-supply during the early period of growth.

With regard to the forward bend of the thighs in young infants, which is constant in all cases, as any one who has the opportunity

for observing can see for himself, this has been accounted for from the fact that the thighs are flexed against the abdomen during the latter part of intra-uterine life. But from analogy with other young creatures, such as those already mentioned and young birds, we find that the pre-natal position has little or no influence in decreeing the habitual attitude of the limbs after birth, and it seems to me more logical and reasonable to trace this also to a prior state of evolutionary development.

Man is, when standing erect, the only animal that has the thigh in a line with the axis of the vertebral column, and among his nearest congeners in the animal world the flexed state of the femoral articulation is natural and constant. As we go down the scale the angle between the thighs and trunk diminishes, until it reaches the right angle characteristic of most quadrupeds. I speak here of the attitude adopted when the animal is at rest upon its legs, for during sleep there is in many cases a curious reversion to the position occupied in embryonic life. Thus we see that a bird roosting with its head "under its wing," and the legs drawn up close to the body, offers a decided resemblance to the chick in the egg.

I have noticed that young children, when old enough to shift their limbs, very seldom sleep in any but the curled-up position; and that as often as not, when unhampered by clothing or other artificial restraints, they sleep in the same attitude as do many quadrupeds, viz., with the abdomen downward and the limbs flexed beneath them. I am told that negro mothers and nurses in the West Indies invariably lay their charges down to sleep on their stomachs, and that this custom is also common in various parts of the world. Adult man is, I believe, the only animal who ever elects to sleep upon his back. Some of the lower savages seem to sleep comfortably on occasion in a crouching position with the head bent down upon the knees, just as all the common tribes of monkeys do. Among the quadrumana it is not until we come to the platform-building anthropoid types that we find a recumbent position habitually taken during sleep. The young orangs and chimpanzees that they have had at the Zoölogical Gardens slept with the body semi-prone and with the limbs, or all except one arm, which was used as a pillow, curled under them. This is exactly the position voluntarily adopted by eighty per cent of children between ten and twenty months old which I have had opportunities of watching. I was told by the attendants at the Zoölogical Gardens that no ape will sleep flat on his back, as adult man often does.

It would be very interesting to get exact observations as to the habits of all the lower tribes of men with regard to sleeping, for it is a point upon which a great deal would seem to depend, if,

as Tylor and most of our anthropologists believe, man's first ideas of a spirit world arose from dreams. We know that most of our domestic animals dream, as is proved by their movements while asleep, and the same thing has also been observed in monkeys. The effect of the position of the body during sleep upon the character of our dreams is too well known to require comment, for probably every one of my readers has experienced the very disagreeable results of sleeping on the back.

Now, if the first glimmerings of another world came to early man through dreams, in which he saw his comrades, or enemies, long since dead, reappear just as in life, though mixed up with much that was incongruous and incomprehensible, it would seem as if the period during which man first adopted the *dorsal decubitus* might have been an epoch-making time in his raw theology.

Devils and devil-worship might easily have originated from a nightmare; and since even dogmas have pedigrees and are subject to the laws of evolution, it is perhaps no very wild suggestion that some of the more somber tenets of our gentle nineteenth-century creeds may owe their embryonic beginnings to the sleeping attitude of some palæolithic divine who had gorged himself in an unwise degree with wild-boar flesh.—*Nineteenth Century.*

SKETCH OF WILLIAM FERREL.

By Prof. WILLIAM M. DAVIS.

SIXTY years ago, the study of meteorology gained a notable impetus from the discoveries then recently made concerning the phenomena of storms. The tempestuous winds had been called to order by the investigations of Dové and Redfield, followed by those of Reid, Piddington, and others in the succeeding decades, and even the literary quarterlies contained reviews of books treating revolving gales. But at that time the understanding of the general circulation of the atmosphere about the earth had hardly advanced from its position early in the eighteenth century, when Hadley first and incompletely explained the oblique course of the trade-winds, as a consequence of their motion upon a rotating globe. In the middle of our century, Dové, then the leader of European meteorologists, taught that all our northeast winds were portions of the return current from the poles, whose battling with the equatorial current gave us our alternations of wind and weather in the temperate zone. In this country, the most commonly accepted explanation of atmospheric circulation was derived from Maury's fascinating Physical Geography of the Sea—a book whose erroneous teachings concerning the source

of our rains in evaporation from the South Pacific Ocean, and concerning the northeast-southwest course of the return polar current at great altitudes, still find recent advocacy by those who would persuade us that cannonading will cause rainfall.

The meteorology of to-day is another science from that of those earlier decades. The store of facts has increased wonderfully, both from the observations made at sea, in good part as a result of the incentive given by Maury, and from the establishment of weather services in many countries following the suggestions of Espy, Henry, Leverrier, and others. The hydrographic offices of various governments have charted the winds of the oceans; Buchan has determined the distribution of barometric pressure over the world, Loomis has discussed more fully than any one else the features of the cyclonic storms whose action is so well indicated on the weather maps.

But from whom has the finer spirit of understanding of all these facts been received? From whom have we now gained an insight into the wonderful correlations that exist among the varied motions of the atmosphere? We would not belittle the ingenious theories of Espy, to whom greater honor is given with the passing years; we would not forget the many contributions made by earnest students at home and abroad; but the fuller appreciation of the system of the winds, both great and small, both in the full sweep of the terrestrial circulation and in the constricted whirl of the tornado, comes from one man—a man lately described by the leading meteorologist of Europe as one "who had contributed more to the advance of the physics of the atmosphere than any other living physicist or meteorologist—a man of whom Americans are justly proud."* Alas that this man is no longer living, and that so few Americans know how proud they may be for having had him for a countryman!

William Ferrel died on September 18, 1891, at Maywood, Kansas, in his seventy-fifth year. The first half of his life was a struggle against adverse circumstances in uncongenial surroundings. His later years saw him on the staff of the Nautical Almanac, in charge of tidal computations in the Coast Survey, Professor of Meteorology in the Signal Service, member of the National Academy of Sciences, and our recognized leader in scientific meteorology. Let those of us whose paths of life have been opened by the labors of our fathers marvel at the innate powers of such a man as this, who made his own way through heavy discouragements.

Ferrel was born in Bedford (now Fulton) County, Pa., on Jan-

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* Dr. Julius Hann, Director of the Austrian Meteorological Observatory, in the Proceedings of the Vienna Academy of Sciences, April 9, 1891.

uary 29, 1817. We are fortunate in having from his own hands a record of his early years. At the request of Mr. A. McAdie, of the Signal Service, Prof. Ferrel wrote, in 1887, an account of his life, and from this Mr. McAdie prepared a biographical sketch that was published in the American Meteorological Journal for February, 1888. The same journal for December, 1891, contains several notices of Ferrel's works by Newcomb, Abbe, and others, read at the October meeting of the New England Meteorological Society. A list of his published writings is given in the Journal for October of the same year. The manuscript autobiography has been presented by Mr. McAdie to the Library of Harvard College, and the following account of Ferrel's youth is prepared from it. Although never widely known, even among our scientific men, his work since his fortieth year gives a record of the latter part of his life; and for that reason the narrative of his earlier years is here given more fully. It is one that may certainly inspire young men who labor under discouragement; and perchance it may also lead the more generous of our readers to seek out and lend a helping hand to those whose lines are hard and who are working earnestly to help themselves; not that all such shall become Academicians, but that well-timed help extended in such directions is the best investment that a man can make for himself and for his country.

Ferrel's father was of Irish and English descent; his mother came from a German family. They lived in a simple way in the country, and the boy went to a common district school. In 1829 the family moved across the narrow western arm of Maryland into Berkeley County, Virginia (now West Virginia). There the son was kept closely at work, except while at school for two winters, the school-house being a rude log cabin, in which he went "through the arithmetic and the English grammar," and then remained out of school till 1839. Having mastered his school-books, he had nothing further to study except a weekly newspaper, the Virginia Republican, published at Martinsburg; this he waited for eagerly, to read its occasional scientific items.

While thus engaged on the farm young Ferrel saw somewhere a copy of Park's Arithmetic, with a sketch of mensuration at its close. Of this he writes: "At the sight of the diagrams I was at once fired with an intense desire to have the book. But I had no money, and at this time I was too diffident to ask my father for even a half-dollar, or to let him know that I wanted the book. Soon afterward I earned fifty cents in the harvest-field of one of the neighbors, and with this I determined to buy the book. The first time I had a chance to go to Martinsburg I inquired for it at a store, but learned that its price was sixty-two cents. I told the store-keeper I had only fifty cents, and so he let me have it at

that price. It was a light task to learn all that was in it." One can not forbear to moralize over this intense desire for knowledge, for what would not such a boy have learned with proper encouragement and opportunity! It must be to these and the succeeding years of hampered effort that Ferrel refers in a few sad words at the close of his narrative: "Much of my time has been wasted, especially the earlier part of it, because, not having scientific books and scientific associations, I often had nothing on hand in which I was specially interested."

It may be said that Ferrel began his career as an investigator in 1832, when on going out one day to work he noticed that the sun was eclipsed. He had not known that such an event was to occur, but it set him to thinking. He had somewhere learned the cause of solar and lunar eclipses, but his materials for further study were only a German calendar, such as farmers use, and a copy of Adams's Geography, with an appendix giving problems on the use of the globes. From these he found that the sun and moon moved with unequal velocities in different parts of their orbits, and that the fastest and slowest motions were at opposite points. Of this he writes: "My theory was that the earth and the moon moved with uniform velocity in circular orbits, and that these orbits were eccentrically situated with regard to the sun and earth. With regard to the moon's path, I knew that it crossed the ecliptic, but I did not know at what angle, and I also at first supposed that the node was fixed. At the beginning of the next year, when the next calendar came to hand, I discovered from the predicted eclipses that the node must recede. I saw from the calendars that there was some cycle of nineteen years, and suspected that this had something to do with the moon's node. This would make the node recede about 19° in a year, as the next year's eclipses seemed to require." Then, with the aid of some older calendars, Ferrel, about at the age of sixteen, proceeded to make out tables of the dates of eclipses in an empirical fashion, but he unfortunately assumed that the diameter of the earth's shadow was constant. "Upon this assumption I spent a vast amount of time, but could get no positions of the nodes or inclination of the orbit which would satisfy the eclipses. The amount of study I gave to the subject both day and night was very great, but I at last gave the matter up in despair. Some time after I was at work one day toward evening on the thrashing-floor, and saw the shadow of a distant vertical plank against the wall; I observed that it was much smaller than the width of the plank, and the reason for it occurred to me at once. I then saw the error of my assumptions with regard to the earth's shadow in my eclipse investigations and was now very anxious to go over again all my computations with the true diameter of the earth's shadow, for, knowing the dis-

tance of the moon and the angular diameter of the sun, I was able to determine this. As soon as I could find time I went over the whole work, and everything came out as satisfactory as could reasonably be expected with my methods. . . . This was in the winter of the first part of 1834. I now ventured to predict by my method the eclipses for the next year, 1835. I determined that there would be three eclipses—two of the moon and one of the sun. . . . I made a record of the whole in a book and awaited for the next calendar for comparison with its predictions. All the circumstances of the lunar eclipses agreed remarkably well, and the greatest error in the predicted times was only nine minutes." And this was the work of a farmer's boy, without help, without encouragement, in the time that he could spare from daily work!

His next book seems to have been Gummere's Surveying, which he mastered in the spring of 1834, with the exception of the miscellaneous examples at the end of the volume, for which no rules had been given and which required a knowledge of geometry. "During the summer, as I had a little time to spare, I dwelt upon these, giving weeks sometimes to a single proposition. It happened that during the summer I was engaged a good part of my time on the thrashing-floor, which had large doors at both ends with wide and soft poplar planks. Upon these I made diagrams, describing circles with the prongs of large pitchforks, and drawing lines with one of the prongs and a piece of board. One by one I mastered all the problems in this way except three. For more than a quarter of a century these diagrams were visible on the doors, and, in returning occasionally to the old homestead, I always went to take a look at them."

This kind of home study continued until 1839, when Ferrel went to Marshall College, at Mercersburg, Pa. Here he learned algebra, geometry, and trigonometry, and gave some time also to Latin and Greek. The next winter he taught near home; but in 1840 he returned to Marshall It was in this year that one of his professors assigned original problems in mathematics to the class. "On one occasion he gave the problem: Given the distances of a well from the three angles of an isosceles triangle, to determine the triangle. . . . This was easy to me at the time, for it was one of the problems which I had solved while at work on the thrashing-floor, with the use of diagrams on the barn-doors, before I had seen a college or a treatise on algebra or geometry."

His money was exhausted in the latter part of 1841, and he went home to teach for two years. Bethany College was then opened in Virginia, and he was admitted to the senior class, and graduated in 1844. It is curious to notice that during all these years there is no mention of apparatus, experiments, or systematic

observations; the boy's work, like that of the man afterward, was almost entirely internal and mental. Thus, at the age of twenty-seven, his schooling was ended, and he left his home and went to Missouri to teach. Failing health compelled him to stop work for a time, and his next engagement was at a small school in Kentucky, where he remained for seven years, until 1854.

While in Missouri he had happened on a copy of Newton's Principia, ordered but never called for by an earlier teacher; he bought it for five dollars, making little advance then on account of poor health, but later returned to it in Kentucky. "I now became first interested in the tides, and conceived the idea that the action of the moon and sun must have a tendency to retard the earth's rotation on its axis. Knowing that Laplace had treated the subject extensively in the Mécanique Céleste, I was very desirous of obtaining a copy, mostly to see what he had in that subject. I accordingly instructed a village merchant, on going to Philadelphia for a supply of goods, to procure me the work, having little idea of the magnitude of the work or the cost. On learning the cost at Philadelphia, he did not procure it for me until after writing and hearing further from me. I had now plenty to study in connection with my teaching for several years." From this followed Ferrel's first scientific paper, On the Effect of the Sun and Moon on the Rotary Motion of the Earth, a subject to which he returned with success in later years.

In the spring of 1854 Ferrel went to Nashville, Tenn., and opened a private school; here Prof. W. K. Bowling, of the Medical College, became his warm friend, and here he first turned his attention to meteorology, from meeting with Maury's Physical Geography of the Sea. "From this book I first learned that the atmospheric pressure was greatest near the parallels of 30°, and less at the equator and in the polar regions; and I at once commenced to study the cause of it. . . . In conversation one day with my friend Dr. Bowling, I told him I had read Maury's book, and he was at once desirous of knowing what I thought of it. I told him that I did not agree with Maury in many things. He then desired me to 'pitch into him,' as he expressed it, and furnish a review for his Journal of Medicine. This I declined to do, but at length consented to furnish an essay on certain subjects treated in the book, and notice Maury's views a little in an incidental way." This was the beginning of the studies in meteorology, which gave a new aspect to the science. The promised article was his Essay on the Winds and Currents of the Ocean. It has since been republished by the Signal Service in Professional Paper No. XII.

In the spring of 1857 the third period of Ferrel's life began on his accepting an offer from Prof. Winlock, transmitted through Dr. B. A. Gould, to take part in the computations for the Nauti-

cal Almanac, then prepared in Cambridge, Mass., and thus opened the happier situation of his later years; but it was not until the spring of 1858 that he finally left Nashville. From this time on he did not lack opportunity for study and acquaintance with scientific men. In 1867 he joined the Coast Survey, then under the superintendence of Prof. Benjamin Peirce, and remained in that service until 1882. The chief results of his work during this period were his Tidal Researches, Meteorological Researches, and his Tide-predicting Machine, all of which contribute to his well-earned reputation.

Ferrel's researches on the tides were in both theoretical and practical directions. His theoretical discussions began in his days of teaching in Kentucky, and in 1853 had led him to conclude that the action of the tides would very slightly retard the rotation of the earth, but at that time no indication of such retardation had been found by astronomers. In 1860, however, it was found that the position of the moon was somewhat in advance of its calculated position; all the known effects of external perturbations having been allowed for, its advance still was unexplained. Ferrel, then living in Cambridge, returned to this problem and showed that the moon's unexplained advance might be accounted for as only an apparent result, the real fact being a retardation of the earth's rotation by tidal action. The essay on this subject was published in the Proceedings of the American Academy of Arts and Sciences in Boston in 1864. An incident in this connection illustrates the diffidence that Ferrel felt in coming in contact with strangers. He carried his essay on The Influence of the Tides in causing an Apparent Secular Acceleration of the Moon's Mean Motion in manuscript to the meetings of the Academy time after time, with the intention of reading it, but his courage always failed, until at last the paper was presented in 1864. Had its presentation been deferred over one more meeting, its appearance would not have antedated a similar essay by the French astronomer, Delaunay, on the same subject.

This was before Ferrel was a member of the Coast Survey; it was naturally followed by his engagement as expert in tidal studies in that office; and when afterward in Washington, he discussed and reduced many tidal observations made at various points on our coast. To lighten the labor of such computations he invented a tide-predicting machine, by means of which the time and value of high and low tides can be mechanically determined for various ports with sufficient accuracy for publication in the official tables, after the constants for the ports are worked out. This machine is now in regular use in Washington, where it is regarded as doing the work of thirty or forty computers. A general work on tides and their theory was among the latest stud-

ies that Ferrel undertook, to be stopped only by the illness that caused his death.

In 1882 Ferrel accepted a professorship in the Signal Service, producing while there several special reports of high value, among which his Recent Advances in Meteorology should have first mention. He also lectured to the officers of the Signal Corps at Washington, and it is from these lectures that he subsequently prepared his Popular Treatise on the Winds, the most comprehensive statement of theoretical meteorology in the English language. He resigned this professorship in 1886, in his seventieth year. He had before this accumulated a competence from judicious investments of the small earnings of earlier years.

Ferrel's name is chiefly connected with his original investigations in meteorology. The first of these was made at Nashville, as stated above, but a more serious study was made in his Motions of Fluids and Solids relative to the Earth's Surface, prepared shortly after going to Cambridge, and published in Runkle's Mathematical Monthly. This is regarded by a most competent critic as "the starting-point of our knowledge of the mechanics of the atmosphere." It is here that he first clearly states the important law that "in whatever direction a body moves on the earth's surface there is a force arising from the earth's rotation which tends to deflect it to the right in the northern hemisphere, but to the left in the southern." This was published in May, 1858, six months before it was discussed, with the same result, in the French Academy of Sciences. Space can not be given here to show the great importance of this principle in meteorology, but if the reader desires to follow it to its applications he should consult the Treatise on the Winds, named above. As to the importance of the principle, let any one attempt to explain the motions of the wind and the distribution of atmospheric pressures without it, and he will soon see the service rendered to meteorology by Ferrel in its introduction. The essential quality of this principle may perhaps be briefly stated.

The general conception of the theory of the winds refers them to convectional movements, arising from the action of gravity on parts of the atmosphere of different temperatures. According to this, the poles, where the temperatures are low, should have high pressures, and the occurrence of low pressures there has been a stumbling-block to more than one writer on the subject; indeed, hardly an English text-book can be named that will lead the student around this difficulty. The consideration introduced by Ferrel is to the effect that the actual distribution of pressure does not depend only on differences of temperature, but also on the motions excited by reason of the pressure differences. The condition of steady motion, under which the winds are impelled by an

acceleration just sufficient to overcome their resistances, requires that the acceleration should be not only the small component of gravity acting on the barometric gradient, but the much smaller resultant of this component acting with the deflective force arising from the motion of the wind itself. The course adopted by the established interchanging circulation between the equator and the poles consists for the most part of a great circumpolar whirl from west to east; and the deflective forces here in play reduce the polar high pressures to low pressures. A reactionary relation therefore exists between the winds and the pressures, by which the distribution of pressures according to temperature alone is greatly modified. Instead of finding high pressure at the cold poles, a low pressure is produced there by the great circumpolar whirl of the general winds, and the air thus held away from the poles accumulates around the tropical belts of high pressure, of which Ferrel had first learned from Maury's book. The absence of northeast return currents (in this hemisphere), except in the trade-wind belt, is as important a feature of Ferrel's theory as the reversal of polar high pressure into low pressure. Maury's erroneous explanation of the winds gained great acceptance from the attractive style in which his book was written; but it is time that his explanation should be abandoned even in elementary teaching, and replaced by more serious views, less easily acquired but of more permanent value.

Ferrel's theory of the winds not only explains the general distribution of atmospheric pressure over the world, as no other theory can do; it introduces broad correlations among many phenomena in meteorology, greatly to the advance of the science. The legitimate analogies that may be drawn between the great circumpolar whirl of the terrestrial winds, the smaller whirls of tropical cyclones, and the concentrated whirling of tornadoes show the unity of action of the convectional processes in the moist atmosphere of a rotating planet. In earlier years, meteorology consisted chiefly of rules for observation and statistical study. The broad generalizations taught by Ferrel raise the science from this simple inductive condition and complete the philosophical rounding of its parts.

Ferrel was not an observer, but he carefully based his studies on well-ascertained facts. He was not an experimenter, but he followed the results obtained by the best physicists. He was a reasoner, able to employ the stronger methods of mathematical analysis. He was sincere and judicial, single-minded and simple-hearted. No one criticised his results more carefully or deliberately than he did himself. He was indifferent to popularity, and took little trouble to enforce his views on the world. He lived a quiet life, more with books than with men, although the few to

whom his closer friendship was given prized it highly. From his isolation as a boy and young man, he was diffident, even to his own embarrassment, in going out to meet others; but to those who came to him he was generous and sympathetic in giving assistance. He never pushed himself forward, and all his official positions came unsought. His earlier essays were inconspicuously published, and never had a wide circulation, even in separate pamphlet form. Many who have received them must have passed them by hardly noticed. The attention of scientific men turned slowly to his work; only in later years than 1870 is his name often mentioned abroad. His preference was always for original methods, in his college demonstrations as well as in later investigations. He did little in the way of restatement of the conclusions of others, but liked better to give his time to original researches in which there was a prospect of discovering something new or of explaining facts that had not been explained before. When his interest was aroused in such work, he devoured everything that he could find about it, "studying almost day and night," and never giving up a problem until it was solved, or until he was satisfied that his labors could not solve it. His conquest of physical problems was not the result of intuitive perceptions alone, but followed patient and persevering work. This appears in his boyhood when he pondered over geometrical problems in the barn, and in later years when his meteorological theories gradually developed.

Ferrel was a man whose teachings reach slowly through the world. Many of the problems that he solved bear only remotely on the lives of the millions of unmarked men from among whom he won his way to eminence; but all who read of him may understand the lesson of his courageous perseverance, of his earnest work and of his simple life. They will do well if, even without adding much to the world's store, they can say as he did at the close of life, "I regret to leave my friends, but that is all I regret."

Attention was drawn by Miss Buckland, at the British Association, to numerous points in which the Navajo myth entitled "The Mountain Chant" reproduces customs and beliefs of the Old World. Among them were mentioned the singular prohibition of food in the abode of spirits, such as appears in the classical story of Persephone, and in modified shape in the fairy folk lore of Europe, in Aino and Japanese tales, and in New Zealand. The author pointed out the great contrast between the bloodless Navajo rites and the sanguinary ceremonies of the ancient Mexicans, and the great dissimilarity in the forms of the Navajo and Mexican gods, as denoting entirely different origins for the two religions, incompatible with the belief commonly entertained of the wholly indigenous character of American culture, and she urged that the Navajo rites point unmistakably to an Eastern origin.

CORRESPONDENCE.

INTELLIGENCE AND THE BELIEF IN EVOLUTION.

Editor Popular Science Monthly:

SIR: Two sentences in your Editor's Table of the January (1892) number excite my surprise. They are these: "Every man within certain limits is an evolutionist, and we have little hesitation in saying that the limits within which each man is an evolutionist are the real limits of his intelligence"; and "we believe—and when we say 'we' we mean all persons with any pretensions to education or intelligence—in evolution as applied to the physical history of our globe." Are these statements consistent with that judicial fairness which all seekers for truth, such as you certainly mean to be, should preserve?

There are many of us who have been diligent students of the works of evolutionists from the appearance of Herbert Spencer's First Principles in 1865. We have read Darwin's volumes carefully, and Huxley's and Tyndall's. We have followed Prof. Gray's beautiful essays. But we are as yet unconvinced "of evolution as applied to the physical history of our globe." There are gaps in the chain which, to our mind, are not filled, nor are in promise of being filled, in material evolution, as at the beginning of *life*. We accept the statement of the authors of The Unseen Universe: "It is against all true scientific experience that life can appear without the intervention of a *living* antecedent." Also at the appearance of new organs, as Prof. Samuel Harris says, after giving Prof. Tyndall's description of the development of the eye: "This certainly is not science; no fact sustains *a single one* of the assumptions. It is a figment of fancy." Then there is the gap between the brute and rational man, where we see *no approach* to a bridge.

Besides this, it seems to us there is much sophistical reasoning among evolutionists, as pointed out by Rudolph Schmid, by S. Wainwright, and especially by Prof. Samuel Harris, in his Scientific Basis of Theism.

There is, too, an initial difficulty in the getting the heterogeneous out of the homogeneous, without a *force from without*, impulsive and directive.

Clerk Maxwell states the difficulty in the way of evolution from molecular science: "No theory of evolution can be formed to account for the similarity of molecules throughout all time, and throughout the whole region of the stellar universe, for evolution necessarily implies a continuous change, and the molecule is incapable of growth or decay, of preservation or destruction. . . . Therefore, for the interaction of molecules, there must be a power from without impelling and directing." Maxwell adds words which we accept: "These molecules continue this day as they were created, perfect in number, measure, and weight; and from the ineffaceable characters impressed on them we may learn that those aspirations after truth in statement and justice in action, which we reckon among our noblest attributes as men, are ours because they are the essential constituents of the image of Him who, in the beginning, created not only the heaven and the earth, but the material of which the heaven and the earth consist."

We would not deny an evolution in the physical work which Prof. Harris calls "scientic," but we would consider it with Prof. Leotze "as a gradual unfolding of a *creative spiritual* principle," and would recognize, with him and Ulrici, "in the evolution both a *mechanical* and a *teleological* process, implying both an energizing and a directing agency."

Now, if in not accepting evolution as ordinarily understood, in holding Darwinism *non-proven*, we show a limit of our intelligence and are excluded from the company of "all persons with any pretensions to education or intelligence," it positively is not from lack of study of what evolutionists have said, and certainly we have some very good company in our limitation and our exclusion; many of them are men who seem to be thoroughly conversant with *all* that has been said for evolution, and they seem to be able to grapple with the arguments.

Do not statements such as you make create a prejudice against evolution among many fair-minded men, and hinder their acceptance of its arguments?

Evolutionists repel with indignation the assertion that they are actuated by a desire to be rid of God and of moral obligation. Need they be surprised if men who have studied diligently what they say, and are yet unconvinced, do repel with equal indignation the assertion of their limitation of intelligence?

Is not the true way to grant each other the fair assumption of *honesty* and honorableness of motive and of intelligence? Is not this the *only* true way for those who would help one another in the search for the one supreme reality—TRUTH?

JOHN R. THURSTON.

WHITINSVILLE, MASS., *December* 22, 1891.

THE EARTHQUAKE OF OCTOBER, 1891, IN JAPAN.

Editor Popular Science Monthly:

SIR: In 1855, on the 11th of November, Japan was shaken by a terrible earthquake. At that time the center of the seismic disturbance was somewhere in the vicinity of

Yeddo (now Tokyo); the great part of the city was laid in ruins, and the loss of life amounted to several tens of thousands, including those who were actually crushed to death by the falling houses and those who, imprisoned in the *débris*, were burned in numerous fires which broke out in various parts of the city; for, as the earthquake occurred at about eleven o'clock at night, the inhabitants were asleep and unprepared to escape from their houses.

On the 28th of last October another part of Japan was visited by a similar catastrophe, of which more details are available than of the above-mentioned earthquake of 1855. The center of this latter seems to have been the valley of Neo, north of the city of Gifu, in the province of Mino. In this city and in the neighboring town of Ogaki the destruction is terrible and the loss of life appalling. Gifu is the seat of government of Gifu prefecture. In Gifu and Aichi prefectures the killed numbered 7,522, the wounded 9,983; the number of buildings wholly destroyed is 88,705; partly destroyed, 28,011; while throughout the entire region over which the disturbance was most seriously felt the totals are: Killed, 7,566; wounded, 10,121; buildings wholly destroyed, 89,629; partly destroyed, 28,626.

Great changes in the geographical features of the provinces of Echizen, Mino, and Owari, at the head of Owari Bay, will evidently result. Land-slips have occurred which completely changed the appearance of the mountain-sides; river channels are dammed by the *débris*, causing inundations of agricultural lands, and large lakes where were cultivated farms.

The total area throughout which the earthquake was felt is stated to have been 39,375 square miles. No serious damage was done in Tokyo or Yokohama. Asama-Yama, the volcano in the provinces of Kodzuke-Shinano, far to the north of the center of the disturbance, was thrown into a state of unusual activity, large quantities of scoriæ having been ejected. Fuji-Yama has also suffered. It appears that, ten minutes after the most violent shock, a noise like a hundred peals of thunder was heard to proceed from the side of the mountain. Some people declare that an immense land-slip, visible soon after the earthquake, has occurred; but before their statements could be verified by careful, scientific investigation, snow fell and obscured the topography.

One of the Japanese newspapers states that at the Okumstama Shrine, in the Nagajima district of Aichi prefecture, Mino province, several fissures were opened from which mud and water were ejected. After the water had drained off, a number of wooden swords, stone axes, and *maga-tama* (beads) were discovered. If this be true, it is a remarkable archæological *find*.

The trembling of earth continues up to the present time, although the shocks are no longer of destructive force. Prof. Milne, of the Imperial University, compares the rumbling sound that accompanies the shocks to that which would be produced by the escape of a great volume of steam through narrow fissures—a colossal steam-horn, in short, roaring and bellowing underground, each of its thunders indicating the explosion of a more or less destructive force.

J. King Goodrich.

Yokohama, Japan, *November 16, 1891.*

COLORS OF LETTERS.

Editor Popular Science Monthly:

Sir: I was greatly interested in the article by President Jordan, on the colors of letters, which appeared recently in your magazine. From my earliest recollections I had always associated various colors with the letters, but never before have I heard of any one else who did so.

Thinking that statistics on this subject might be of interest, I send you my list of alphabet colors:

A. Dull yellow.	N. Tin color.
B. Dark.	O.
C. Like kerosene-flame.	P. Nearly like H.
D. Black.	Q. Red.
E. Like A.	R. Black.
F. Dark.	S. Silver color.
G. Gray.	T. Dark.
H. Slate color.	U.
I. Black.	V. Like J.
J. Dirty brown.	W.
K. Black.	X. Red.
L. Black.	Y.
M. Dark red.	Z. Red.

Those left blank are associated in my mind with a color, but I am unable to define it; and certain of the descriptions used do not fully convey the idea.

It has been suggested to me that my connecting color with the letters arose from the colors on the blocks from which I learned them. This might account for red, black, and white, but certainly would not account for the other shades.

My own explanation of the matter is this: When we are learning to spell we associate certain letters with certain words, and those words give us the idea of color. These words may be said to be *chromopoetic*, and this property, if it may be so called, can not be dissociated from them. For illustration, D is associated in my mind with dog, and when I think of dog it never is a white dog, but always a black one; hence, D is black. I brings up ink and black ink; J, a jug of brown color; V is a vulture, which I always think of as brown.

In many cases I am unable to trace the connection between the letter and the color, but I feel sure it exists somewhere in my mind. If this possesses sufficient interest to your readers to warrant its publication, you are at liberty to do so.

James S. Stevens, Professor of Physics.

Maine State College, Orono, Me., *Aug. 15, 1891.*

EDITOR'S TABLE.

EDUCATION AND ETHICS.

ONE of the most serious questions of the present day is as to where and how adequate moral instruction is to be imparted to the rising generation. In the olden time there was no question as to the full responsibility of the home aided by the Church for the moral training of the child. School education was obtained with more or less difficulty, and, when a child was sent to school, the connection between school and home was close. The parent paid for the teaching, and master and parent worked as a general thing on the same moral lines. Nowadays, owing to the vast extension of popular education through the agency of the State, and the abolition of all direct payment of school fees, there is a severance of the former relation between home and school, and the moral interests of the children seem to be slipping to the ground between two stools. The State takes from the parent nearly all initiative in regard to the education of the child, and does so much that the parent is easily led to imagine that it does everything—that it teaches the principles of right conduct no less than the rules of grammar and arithmetic, and practices the young in virtue as systematically as in handwriting. How far this is from being really the case any one can learn on inquiry; but the vague assumption that it is the case, or ought to be the case if it is not, does a great deal, we are persuaded, to diminish the sense of parental responsibility.

From the side of religion many protests have been made against the present system of popular education. The clergy of the different churches can not help thinking that at least the more important doctrines of the Christian faith should be officially taught; and they draw most discouraging pictures of what the moral future of the youth of this country will be if their counsels are not heeded. All sound and successful moral teaching, they contend, must repose upon a basis of theology, and to confine ethical teaching to the region of the natural is to deprive it of all warrant, of all authority, of all coercive power. If these views were correct, it would be difficult to see how the weakness of our schools on the moral side could ever be remedied; for nothing is more certain than that any attempt to teach theology in them would be predestined failure. The people (or some people) will pay for theology in the pulpit, but they are not willing to pay for it in the schools, and have shown in most unmistakable ways that they do not want it there. The question, then, is: Shall all attempts at moral teaching in the public school be abandoned, seeing that it can not be administered as an adjunct of theology; or shall a brave effort be made to give it an independent status of its own and a fair chance to show what it can accomplish when conducted on purely natural lines? The latter is the decision that some earnest minds have come to, and we have at this moment before us a book produced for the express purpose of aiding the good cause. This work, published by Messrs. Houghton, Mifflin & Co., bears the title Conduct considered as a Fine Art, and consists of two essays written in response to a call from the American Secular Union for "the best essay, treatise, or manual adapted to aid and assist teachers in our free public schools . . . to thoroughly instruct children and youth in the purest principles of morality without inculcating religious doctrine." Mr. N. P. Gilman, who writes the first half of the book, and whose essay bears the special title of The Laws of Daily Conduct, shows very plainly how unnecessary it is in dealing with children to do more than illustrate

moral principles from the experience of daily life. Children do not call for metaphysics; and to refrain from teaching them the principles of morals because you are not prepared to discuss with them those ultimate questions as to the final sanction of morality which are debated by philosophers and theologians, is like withholding from a builder all knowledge of the practical applications of geometry, because you can not carry him into the calculus, or make him feel at home in the fourth dimension. Mr. Gilman states his position very well in the following passage: "When, then, we have in mind, as a subject for public school instruction, not the science of ethics, not the speculations of moral philosophers, but the orderly presentation of the common facts and laws of the moral life which no one disputes, we perceive how the religious or theological difficulty disappears to a large degree. . . . Let the relation of religion and morality be as it may be, the teacher is not called upon to decide an issue of this magnitude. He can teach the duties of ordinary life, showing their reasonableness and their interdependence in a consecutive, orderly manner, without appealing to religion; he can use the plain and usual consequences of actions good or bad without being open to a just accusation of irreligion. These consequences are admitted by all. He has then a right in reason to stop with them, because of the practical limitations imposed upon him by the time at his disposal, the immaturity of the faculties which he is training, and, most of all, because of the wide difference of men's minds as to the final explanation."

Mr. Gilman makes due allowance for the fact that a well-ordered school has "a necessary moral discipline of its own, which is enforced by every capable teacher"; but he does not think that this should be regarded as a sufficient substitute for all direct moral teaching. He considers that the school has some special advantages for effective ethical teaching which the home does not possess, and that a teacher throws away very valuable opportunities who does not find frequent occasion for bringing home moral lessons to the minds of his pupils. In this we wholly agree with him. The teacher has what the parent has not, an ever-present and more or less numerous body of hearers, to whose common judgment he can appeal; and he has the established order and discipline of the school as a means of commanding attention. Moreover, the teacher's judgment is already assumed by the child to be more or less the judgment of the outside world, whereas the parent's opinion, like his jurisdiction, is apt to be looked upon as valid only within the limits of the household. It is evident, therefore, that a vast influence for good might be exerted by the teacher, provided only he himself possessed the requisite intelligence and earnestness. The real weakness of our public schools for the purpose in view comes to light just here. Before any teacher could make a wise and effective use of such a manual as the one before us his heart would have to be in his work; he would have to possess a really apostolic zeal for the moral benefit of the children committed to his care. Are such teachers numerous? Is there anything in the conditions under which teachers are trained and selected to encourage the hope that very many of them would, under any circumstances, be earnest exponents of moral truth? We are really not aware that there is. In the vast army of public-school teachers there must be many superior minds and many noble souls; but those who have studied our school system seem to be impressed rather with the lack, than with the presence, of what we may perhaps call ethical vitality in both teachers and scholars. A teacher must outwardly bear a good character; but what examination has ever been devised to test his or her interest in ethical questions or principles, in the

stimulation of virtue or the building of character?

Still, we quite hold with those who consider that the schools ought to aim at the production of good citizens, and that, for this purpose, they should teach, with such resources as they can command, the principles of right conduct. The book before us will be useful to those who desire help in this direction. Mr. Gilman has excellent chapters on "Life under Law," "Obedience to Moral Law," "Self-control," "Truthfulness," etc., etc.; and Mr. E. P. Jackson, who contributes the second half of the book, throws his discussion of very much the same topics into the form of a series of dialogues between a teacher and his pupils. Each writer has done his work well, and the teacher who has the will to teach his or her scholars what is right will find the whole book very profitable.

We return, however, to the point with which we set out, that parental influence to-day in the moral education of children counts for too little. Mr. Gilman tells us that "numerous educators" object to giving any special instruction in morals, alleging that that is the parent's business. He might have told us, we are persuaded, from his own knowledge, that still more parents are disposed to shuffle off all responsibility for the moral education of their children on the schools. What the effect of the double disclaimer of responsibility is likely to be may readily be determined. If the clergy, instead of making futile demands for the teaching of theological dogmas in the schools, would try to rouse the minds of their adherents and followers to a sense of their personal responsibility for their children's characters, they might accomplish a more useful work. This is something which they should preach in season and out of season; and if they would do so with the earnestness which the occasion demands, the effect might in a few years be seen in the altered moral tone of a portion of the public-school teachers themselves; and thus, concurrently with the elevation of the home, we should have a notable improvement in the work of moral education as carried on in the schools. Reform the home, and the whole face of society will be reformed.

EVOLUTION AND INTELLIGENCE.

We publish in another column a letter from a correspondent who thinks that, in our article entitled Evolution and its Assailants, in the January Table, we cast a slur upon the intelligence of those who do not, in the fullest sense, accept the doctrine of evolution. The following is the statement to which our correspondent objects: "Every man within certain limits is an evolutionist, and we have little hesitation in saying that the limits within which each man is an evolutionist are the real limits of his intelligence." We hardly thought this would be misunderstood, but it evidently has been by one person at least. The word "intelligence" has two very familiar meanings. In one application it means the power a given individual has of comprehending things in general, and thus expresses a personal quality. This is the sense in which we did *not* employ the word. Again, it may mean the act or function of understanding, and this was the sense in which we *did* employ it. To say in this sense that "the limits within which each man is an evolutionist are the real limits of his intelligence," is to say that *beyond those limits he ceases to understand.* We wonder that a man who professes to be so widely read in philosophy and science as our correspondent should not have perceived that this was our meaning, and not that a man *begins to be stupid* just where he ceases to believe in evolution. The passages which our correspondent cites from some of his favorite authorities prove that we were exactly right in the position we took up, for they all go to show that, in the chain of events which make up the

history of our globe, there are some which baffle comprehension. In a certain sense evolution itself may be said to baffle comprehension, since the human intellect can never fully understand how one thing can become anything else; but the general processes of evolution are at least illustrated by facts which long and repeated experience has rendered very familiar. On the other hand, there is nothing analogous to any well-established human experience in the miraculous interference which those have to postulate who either reject evolution altogether, or only recognize it to a limited extent.

Our correspondent also objects to our statement that "all persons with any pretensions to education or intelligence believe in evolution as applied to the physical history of our globe." At the moment we were thinking more of the globe itself than of its living inhabitants; and before objecting to our statement our correspondent might properly have raised with himself the question whether we meant more than we actually said. However, on points like these there will, of course, be differences of opinion, and we must only ask our correspondent to believe that we meant no disrespect in anything that we said to persons of his way of thinking. We believe in evolution because it has already explained so many things, and because its scope as a scientific theory is continually widening. If our correspondent declines to accept it on such grounds as he alleges in his article, he is quite within his right. What he has not shown us is what phenomena or events to which the doctrine of evolution has no application he really *understands*.

LITERARY NOTICES.

My Canadian Journal, 1872–'78. By the Marchioness of Dufferin and Ava. New York: D. Appleton & Co. Pp. 456. $2.

The Journal consists of extracts from letters written home to the author's mother while Lord Dufferin was Governor-General of Canada. Although—the letters having been written from twelve to twenty years ago—it is rather an account of the past than a description of the present, and Canada has undergone a great development, its villages having become towns and new railways having developed cities in what was the wilderness, the Journal has lost none of its freshness; for it is the record, made on the spot and at the moment, by a keen observer of cultivated intelligence, disposed to make the best of everything that she saw and experienced; and such records are always fresh. So we are given, in the familiar style which intimate friendship authorizes, yet always graceful, sketches of travel, adventure, scenery, society, social and economical conditions, sports, more serious occupations, and whatever is of the life of the country. The pictures are of all seasons through eight years; they cover all parts of Canada, the St. Lawrence, the lakes, the Maritime Provinces, the west, northwest, and Pacific coast, and the Eastern Townships, with occasional excursions into the United States, concerning which the author is sorry to pass so lightly over the cordiality and the friendliness that were invariably shown her and her husband—"for whether we were traveling officially through Chicago or Detroit, or went as ordinary visitors to New York or Boston, we were always received with a kindness and cordiality which we can never forget."

Studies in Aërodynamics. By S. P. Langley. Smithsonian Institution. 1891.

This monograph of Prof. Langley is the record of four years' experimental work with the inclined plane, to determine the conditions to be complied with in moving such a plane through the air, the power required, etc. His work has thoroughly convinced him of the practicability of moving such planes through the air with our present means of propulsion. It has generally been thought that the one essential element needed to be provided, in order to make mechanical flight possible, was an extremely light and powerful motor. But Prof. Langley's experiments have shown that we need not make a search for such a motor, as the steam-engine, in the forms we now possess it, is quite equal to the occasion. His ex-

periments have demonstrated the somewhat remarkable fact that the power required to sustain an inclined plane, when inclined at a slight angle to the horizontal and driven forward, decreases with the speed. He finds that there is a speed for any given plane at which the plane becomes self-supporting, or rather in which it tends to rise. This speed he terms the soaring speed, and when it is reached the weight becomes unimportant. With greater weights it is only necessary to drive them at greater speeds in order to eliminate the element of weight. The practical conclusion from this is that we are not prohibited by the weight of our apparatus from achieving mechanical flight, and the problems to be solved are not those connected with the question of weight, but rather those concerning the details of construction by means of which the apparatus may be controlled while under movement and in ascent and descent, so as to be safe and manageable. The method of experiment adopted by Prof. Langley consisted in mounting an inclined plane at the end of the arm of a whirling table sixty feet in diameter. This table was driven by power at such a rate that a speed of one hundred miles an hour could be attained. The plane was mounted in such a way that it was free to fall, and, by a number of ingenious appliances designed by Prof. Langley, the power which would be required to drive the plane in free air at the speeds attained could be measured. The numerical result arrived at by the experiments is that by the expenditure of one horse-power a weight of two hundred pounds can be transported through the air at the rate of forty-five miles an hour. As a steam-engine of this power can be built to weigh not more than one tenth of this amount, it will be seen that there is a wide margin between the weight of the motor and the total weight which can be moved by it. When we consider the vast practical results which would follow the successful navigation of the air, the value of experiments such as these which supply us with data necessary to a solution of the problem can not well be overestimated. It is to be hoped that Prof. Langley will be able to continue his experiments until all the problems bearing upon this interesting and important subject shall have been solved.

The Journal of Physiology. Edited by Michael Foster. Cambridge, England: Cambridge Engraving Company. Vol. XII. Price, $5 a volume.

The editor has the co-operation in conducting this journal—the foremost one of its class—of Professors W. Rutherford and J. Burdon-Sanderson, in England, and Professors H. P. Bowditch, H. Newell-Martin, H. C. Wood, and R. H. Chittenden, in the United States. The journal is published in numbers which appear not at rigidly fixed times, but at varying intervals, determined by the supply of material. The present volume consists of five numbers, the last one of which is made up of parts five and six, and contains thirty-one articles in original experimental physiological research. These articles relate to different elements of animal organisms; to the circulation, the nervous system, the action of various substances on bodily functions and products; respiration, temperature relations, the excretions; and to apparatus. They are prepared by careful and accurate experimenters, many of whom are experts or physiologists of world-wide reputation, and record in minute detail what they have themselves observed; the observations being usually accompanied by charts showing the graphic records made by the instruments used.

A Popular Hand-book of the Ornithology of the United States and Canada. Based on Nuttall's Manual. By Montague Chamberlain. Boston: Little, Brown & Co. Two volumes. Pp. xlvii + 473, and vii + 431. Price, $8.

The first volume of Nuttall's Manual was published in 1832, and the second in 1834. The book was the work of a master of the ornithological knowledge of the day, and of an author who commanded a warm literary style with fine powers of description. It was the first hand-book of the subject that had been published, and was carried at once into favor, not less by its innate qualities than by the interest of the subject. While a great advance has been made in scientific or technical ornithology, the study of bird-life, the real history of our birds, remains just about where Nuttall and his contemporaries left it. We have brilliant and engaging essays on various aspects of it by such writers as Bradford Torrey, Mrs. Miller, and

Frank Bolles; but they do not appear in the hand-books, and, as Mr. Chamberlain remarks, "in comparison with the work accomplished by the older writers, and with that which is still unknown, the recent acquisitions must be considered slight." Nuttall's work has been out of print for several years; but its popularity and real value have kept it in demand, and the few copies recently offered for sale were disposed of at high prices. In publishing the new edition instead of issuing it in the form of the original, or remodeling it to the extent that would be required to arrange it in harmony with the new system in ornithology, the editor has reproduced Nuttall's biographies with few changes beyond pruning them of what was obsolete; has added, in notes distinguished by smaller type, such new facts as seemed needed to bring the descriptions into conformity with the present state of the science; has rewritten the descriptions of plumage, endeavoring to phrase them in well-known and untechnical terms, so that they may be understood by unskilled readers; and has added a description of the nest and eggs of each species. The untechnical character of the work, and the use of simple, well-known terms in the descriptions, are a feature on which the publishers speak with some pride. Canadian readers have been kept in mind, and accounts are given of every species that has been found within the Dominion east of the Manitoba plains, and of their Canadian distribution. The editor is a specialist in ornithology, on which he has published numerous articles in periodicals devoted to the science and monographs. We were interested in reading Nuttall's introduction, which is given entire and unchanged, a foreshadowing of the doctrine of protective mimicry which has been made prominent by Mr A. R. Wallace. Some birds, it is observed, "are screened from the attacks of their enemies by an arrangement of colors assimilated to the places which they most frequent for subsistence and repose; thus the wryneck is scarcely to be distinguished from the tree on which it seeks its food; or the snipe from the soft and springy ground which it frequents. The great plover finds its chief security in stony places, to which its colors are so nicely adapted that the most exact observer may be deceived. The same resort is taken advantage of by the night-hawk, partridge, plover, and the American quail the young brood of which squat on the ground, instinctively conscious of being nearly invisible, from their close resemblance to the broken ground on which they lie, and trust to this natural concealment. The same kind of deceptive and protecting artifice is often employed by birds to conceal or render the appearance of their nests ambiguous. Thus the European wren forms its nest externally of hay, if against a hay-rick; covered with lichens, if the tree chosen is so clad; or made of green moss, when the decayed trunk in which it is built is thus covered; and then, wholly closing it above, leaves a concealed entry in the side. Our humming-bird, by external patches of lichen, gives her nest the appearance of a moss-grown knot. A similar artifice is adopted by our yellow-breasted fly-catcher, or vireo, and others." The first volume is devoted to land birds, the second to game and water birds. The accounts are confined to birds known east of the Mississippi Valley. The work is published in beautiful style, with pictorial illustrations that it would be hard to excel of most of the species, and a colored plate in each volume.

Christianity and Infallibility: Both or Neither. By the Rev. Daniel Lyons. New York: Longmans, Green & Co. Pp. 284. Price, $1.50.

This book bears the *nihil obstat* (no objection) of D. Pantanella, S. J., and the imprimatur of the Roman Catholic Bishop of Denver. It was written under the influence of the conviction which the author believes the logic of facts is daily confirming, that "Christianity, to maintain its rightful hold on the reason and conscience of men, needs a living, infallible witness to its truths and principles; a living, infallible guardian of its purity and integrity, and a living, infallible interpreter of its meaning." The doctrine of infallibility, he believes, "goes to the very root of the Christian controversy, and supplies the only complete and satisfactory solution of the many and grave difficulties which it involves." Grant it, and in it "you have a ready, easy, and at the same time a perfectly satisfactory solution of the religious controversy with all its difficulties. Reject

the doctrine of infallibility, and your path, as a believer in Christianity, is beset with insuperable difficulties." Protestants, it appears, have very erroneous conceptions of the meaning of this doctrine, which if they were correct would rightfully condemn it. As defined by the author, its true meaning is that "the Pope, by virtue of a special supernatural assistance of the Holy Spirit of Truth promised to him, in and through St. Peter, is exempt from all liability to err when, in the discharge of his Apostolic Office of Supreme Teacher of the Universal Church, he defines or declares, in matters of or appertaining to Christian faith or morals, what is to be believed and held, or what is to be rejected and condemned by the faithful throughout the world." Besides the meaning of infallibility, which is thus summarized, the author considers the reasons why Catholics believe in the dogma of infallibility, the way they meet the objections to it, and—in the appendixes—The Happiness of Converts, Some Facts relating to the Vatican Council, and Pontifical Decrees and the Obedience due to them.

The Two Republics; or, Rome and the United States of America. By Alonzo T. Jones. Battle Creek, Mich.: Review and Herald Publishing Co. Pp. 895. Price, $2.50.

The purpose of this book is to study the interrelationship of government and religion, in respect to which Rome and the United States are regarded as occupying the two extremes. "The principle of Rome in all its phases is that religion and government are inseparable; the principle of the Government of the United States is that religion is essentially distinct and totally separate from civil government, and entirely exempt from its cognizance. The principle of Rome is the abject slavery of the mind; the principle of the United States of America is the absolute freedom of the mind. As it was Christianity that first and always antagonized this governmental principle of Rome, and established the governmental principle of the United States of America, the fundamental idea, the one thread-thought of the book, is to develop the principles of Christianity with reference to civil government, and to portray the mischievous consequences of the least departure from those principles." All Sunday legislation is so strenuously opposed, that this may be regarded as the chief purpose of the book. The Rome that is treated of is that which was brought into relation with Christianity, the empire, and the papacy. The persecutions of the Christians, which are regarded as simply the legitimate outcome of the impartial enforcement of the laws when inflicted by good emperors, and as a part of their undiscriminating viciousness when inflicted by bad ones, are considered the legitimate results of the union of Church and State. As Christianity became stronger, it is charged with having adopted heathen features as a means of making its way more rapidly—"the great apostasy"—and particularly those connected with the worship of the sun (which is supposed to be, of all pagan cults, the most abhorrent to Jehovah), and among them the consecration of Sunday. The growth of other features held to be in conflict with pure religion and freedom is traced through the lives of emperors and popes. The transplantation of some of them, even after the Reformation, to America, and their gradual elimination under the workings of our free institutions; and the efforts, in recent years, by the National Reform Union, the Sabbath Union, and other societies, to secure the incorporation in the Constitution of a recognition of the Christian religion, and the enforcement of Sabbath laws, are successively reviewed. "As surely," the author concludes, "as the movement to commit the Government of the United States to a course of religious legislation shall succeed, so surely will there be repeated the history of Rome in the fourth and fifth centuries," and our republic will "be led captive in the ruinous triumph of the papacy."

The Positive Theory of Capital. By Eugen V. Böhm-Bawerk. Translated, with a Preface and Analysis, by William Smart, M. A. London: Macmillan & Co. 1891. Pp. 428. Price, $4.

In this volume Prof. Böhm-Bawerk deals with one of the vexed questions of economics—the economic basis of interest—with the question why the lender of a sum of money, for instance, should demand at the end of the period for which it is lent, not only the original sum, but a bonus as well.

The different theories which have been

advanced by economists to account for interest have been reviewed and subjected to criticism by the author in his previous work, Capital and Interest. This destructive criticism he now follows by a positive construction of his own, in which he seeks to find a lasting basis for the phenomenon of interest, in a theory which does not necessitate the resort to questionable hypotheses to support it. This basis he finds in considering interest, not as a bonus paid for the use of capital, but as a surplus arising from the greater value of present goods over future ones. He regards the transaction, say, of the loan of a sum of money and the payment of interest for it, as a case of the exchange of goods—the exchange of present goods for future ones.

As present goods are more desirable than future ones of the same face value, they command a premium, and this premium is interest. The following extract from the author's discussion of the sources of interest sets forth clearly his own views, as well as his estimate of previous explanations:

"In the previous book I have tried to show, and account for, the natural difference that exists between the value of present and the value of future goods. I have now to show that this difference of value is the source and origin of all interest on capital. But, as the exchange of present commodities for future commodities takes various forms, the phenomenal forms of interest are as various, and our inquiry must necessarily deal with them all. In the following chapters, therefore, I intend to take up, in succession, all the principal forms of interest, and I shall endeavor to show that, notwithstanding all differences in shape and appearance, the active cause in them all is one and the same—namely, the difference in value between present and future goods.

"By far the simplest case of this difference in value is presented in the loan. A loan is nothing else than a real and true exchange of present goods for future goods; indeed, it is the simplest conceivable phenomenal form, and, to some extent, the ideal and type of such an exchange. The 'lender,' A, gives to the 'borrower,' B, a sum of present goods—say present pounds sterling. B gets full and free possession of the goods, to deal with as he likes, and, as equivalent, he gives into A's full and free possession a sum of entirely similar, but future, goods—say, next year's pounds sterling. Here, then, is a mutual transfer of property in two sums of goods, of which one is given as recompense or payment for the other. Between them there is perfect homogeneity, but for the fact that the one belongs to the present, the other to the future. I can not imagine how an exchange in general, and an exchange between present and future goods in particular, could be expressed more simply and clearly. Now, in the last chapter we proved that the resultant of the subjective valuations which determines the market price of present and future goods is, as a rule, in favor of present goods. The borrower, therefore, will, as a rule, purchase the money which he receives now by a larger sum of money which he gives later. He must then pay an 'agio' or premium (*Aufgeld*), and this agio is interest. Interest, then, comes, in the most direct way, from the difference in value between present and future goods.

"This is the extremely simple explanation of a transaction which, for hundreds of years, was made the subject of interpretations very involved, very far-fetched, and very untrue."

Prof. Böhm-Bawerk considers the profit of capitalist undertakings as a case of interest, and explainable by his formula, on the ground that the "owners of capital are merchants in present goods, such goods being more valuable than the "future goods"—labor, uses of land, and capital—which the capitalist buys. While this work is primarily addressed to economists, it is quite within the range of the general reader who is interested in economic questions.

Electricity and Magnetism. Translated from the French of Amédée Guillemin. Revised and edited by Silvanus P. Thompson. Macmillan & Co. 1891. Pp. 967. Price, $8.

The industrial applications of electricity have been so many and so varied, and they have increased at so great a rate in recent years, that the subject of the uses and possibilities of this marvelous agent possesses an interest for the general public shared by none of the other great agencies which have contributed so largely to our material advancement. This interest has been both sustained and augmented by the many popu-

lar expositions which have appeared in recent years, in which the principles of the science and their application to the arts have been told in plain, simple, and attractive language. Already the popular literature of the subject is large, and keeps pace with the advance in industrial and technical uses. Of recent contributions of this character the work of M. Guillemin is one of the most notable. The work covers a general exposition of the science of electricity and magnetism, and then brief and concise descriptions of apparatus and appliances. In the division devoted to the industrial applications, the subjects considered are—the mariner's compass, lightning-conductors, telegraphy, the telephone, microphone, and the radiophone, electric clock-work, motors, transmission of power, electric lighting, electro-plating, and various minor applications. In an appendix Prof. Thompson gives a brief account of the modern views of the nature of electricity, based upon the researches of Faraday and Maxwell.

The book is handsomely got up, printed in large type, on heavy calendered paper, with wide margins, and is very fully illustrated.

Mental Suggestion. By Dr. J. Ochorowicz, with a Preface by Charles Richet. New York: The Humboldt Publishing Company. Pp. 361. Price, $2.

As we gather from the concluding chapter of this work, by mental suggestion is meant a "dynamic correlate" sent forth by thoughts in every direction. Thoughts do not travel; "no substance is carried hither or thither, but a wave is propagated and modified more and more according to the different natures and the different resistances of the media it traverses." It is mental action at a distance, upon subjects which have to be in a proper *rapport* or relation to the acting thought. By it the phenomena of hypnotism, occultism, which it does not favor but banishes, and kindred mysteries are supposed to be accounted for. According to Dr. Richet's interpretation, the theory means that "independently of any phenomenon appreciable by our normal senses or by our normal perspicacity, how quick soever it may be supposed to be, there exists between the thought of two individuals a correlation such as chance can not account for." Dr. Ochorowicz sets forth a multitude of facts which have been observed by himself and by sundry experimenters, criticises them vigorously and seeks to eliminate the difficulties that might arise from fraud or chance, and to present the conclusions which seem to be established. Yet Dr. Richet does not maintain that his argument produces conviction, but only doubt. "So strong in its action upon our ideas is the influence of routine and of habit," which have taught us to ignore the conclusions to which the phenomena would lead an unprejudiced mind. "But," Dr. Richet adds, "whatever the opinion ultimately formed as to the reality of mental suggestion, it ought not, I think, to influence one's judgment as to M. Ochorowicz's book. Everybody, it seems to me, must recognize his sincerity, his perseverance, and his contempt for ready-made opinions. One feels that he has a passionate love of truth." The body of the work consists largely of citations of incidents apparently or really illustrating the doctrine of mental suggestion, with the author's criticisms and comments upon them, and the conclusions drawn from them.

Solutions. By W. Ostwald. Translated by M. M. Pattison Muir. London and New York: Longmans, Green & Co. Pp. 316. Price, $3.

The volume here offered to chemists is a portion of the author's Lehrbuch der allgemeinen Chemie, a second edition of which was issued toward the end of 1890. Sufficient reason for its translation and publication by itself is given in the appearance and rapid growth during the last three or four years of van 't Hoff's theory of solutions. An authoritative statement of this theory, together with a systematic setting forth of the great mass of facts about solutions that have been accumulated, has obvious value for chemists at the present time. The eminent rank of the translator among English chemists, together with the fact that he has had the co-operation of the author in preparing this version, insures that the treatise has lost nothing in the process of translation. It has, in fact, gained the benefit of some slight revisions, and some additions from memoirs published in the first half of 1891.

The Practical Telephone Hand-book. By Joseph Poole New York: Macmillan & Co. Pp. 288. Price, 75 cents.

The task which the author of this handbook has performed is a presentation of the art of communication by telephone as it is now practiced. To this end he describes the batteries, receivers, transmitters, signaling apparatus, and switch-boards in general use, the systems employed in operating telephone exchanges, modes of constructing telephone lines, together with the poles, wires, insulators, and other material required in the construction. Long-distance working is also treated, and underground work and the localization of faults are not omitted, while a few minor or very recent topics are included in a miscellaneous chapter and an appendix. The volume is a thoroughly practical one and is fully illustrated.

Modern American Methods of Copper-smelting. By Edward Dyer Peters, M. E., M D. Second edition, revised and enlarged. New York: The Scientific Publishing Company. Pp 398.

The author has dealt most largely in this work on facts gleaned from his own experience, while he has aimed to touch upon theoretical questions only when it was essential for the understanding of practical facts. Much attention has been given to matters of cost, both of construction and subsequent operation, and in this expenses are given, not as calculated on paper, but as actually incurred in building on a large scale and in smelting many thousand tons of ores under various circumstances, and in all the ordinary kinds of furnaces. The first edition of the book was published in 1887. For the second edition such new material as time and experience have suggested has been added. But the advances in copper-smelting since the work first appeared have been rather in a general enlargement of furnaces and apparatus than in any radical changes or inventions. A section on the electrolytic assay of copper has been prepared by Mr. Francis L. Sperry, of Sudbury, Ontario, and information and plans of the regenerative gas-furnaces used at Atvidaberg, Sweden, have been furnished by Mr. Paul Johnson. It is in these regenerative gas-furnaces that the author expects to see realized the vital point of economy in the use of fuel. In the first chapter the ores of copper are described; in the second, their distribution is pointed out. The chapters that follow concern methods of copper assaying, the roasting of copper ores in lump form, stall roasting, roasting in lump form in kilns, calcination of ore and matte in a finely divided condition, the chemistry of the calcining process, smelting, blast-furnaces, the smelting of pyritous ores containing copper and nickel, reverberatory furnaces, refinement of copper with gas in Sweden, treatment of gold and silver bearing copper ores, and the Bessemerizing of copper mattes.

A Graduated Course of Natural Science. By Benjamin Loewy, F. R. A. S., etc. Part II. London and New York: Macmillan & Co. Pp. 257. Price, 60 cents.

The second installment of this course of study consists wholly of experiments, most of them being in the domain of physics, but some in that of chemistry. The elementary laws and principles of mechanics, acoustics, optics, and electricity are successively brought out, and a few forms of chemical action are illustrated. A list of questions is given on the work included in each chapter. This part of the course is designed for young students, hence the directions and interpretations of the experiments are given in simple language. An appendix contains hints for performing the experiments, and there are sixty diagrams of apparatus in the body of the book. The author states that he has throughout aimed at rendering the experiments feasible with a very limited apparatus, and inexpensive materials and appliances.

Electricity Simplified. By T. O'Conor Sloane. New York: Norman W. Henley & Co. Pp. 158. Price, $1.

The objects of this little book are to explain the commonly accepted theory in regard to the action of electricity, and to describe the various ways in which electrical energy has been practically utilized. The theoretical part of the subject most needs explanation, and hence naturally receives most attention. Among the practical questions of popular interest that are answered are, How long does it take to send a signal

across the Atlantic Ocean? how are cars on electric railroads worked? and under what conditions can a fatal shock of electricity be received? The text is illustrated with twenty-nine figures.

The Story of our Continent. By N. S. Shaler. Boston: Ginn & Co. Pp. 290. Price, 85 cents.

The study of the ordinary text-books on geography gives pupils a minute acquaintance with the features of each division of a country, but leaves them without any broad view of the country as a whole, and without any appreciation of the relations of one section to another. This lack with respect to North America Prof. Shaler has aimed to supply by means of a reader in geography and geology telling how this continent grew into its present form, what aboriginal peoples are known to have inhabited North America, how the form of the continent has affected the history of its several groups of colonists, and what are its resources and commercial condition. Comparisons with some features of the Eastern Continent are introduced in the course of the description. The volume is illustrated and has an index.

Part XIX (July, 1891) of the *Proceedings of the Society for Psychical Research* contains three principal papers, all of which embody reports, confirmed by several witnesses, of so-called psychic phenomena. The first paper, by Mr. F. W. H. Myers, is On Alleged Movements of Objects, without Contact, occurring not in the Presence of a Paid Medium. These movements include the rising of tables from the floor, knockings, ringing of bells, writing on slates, and the moving of chairs and various smaller articles. A record of Experiments in Clairvoyance is contributed by Dr. Alfred Backman, of Kalmar, Sweden. The cases given include seeing ordinary actions at a distance, describing a murderer and his house, describing Christmas presents some days before Christmas that the King of Sweden was to receive, and finding a miniature revolver that had been lost in a field. Dr. Richard Hodgson describes A Case of Double Consciousness occurring in a preacher named Bourne, living in Rhode Island. Mr. Bourne wandered from his home in 1887 and set up a small store in Norristown, Pa., which he kept for six weeks before recovering his identity. Mr. Bourne has been several times hypnotized and questioned by Dr. Hodgson, Prof. James, and Dr. Morton Prince. A supplement contains a Third *ad interim* Report on the Census of Hallucinations, covering returns received in England and in France, a reply to Mr. A. R. Wallace on Spirit Photographs, by Mrs. Henry Sidgwick, and two notices of books. Dr. Richard Hodgson, 5 Boylston Place, Boston, is the agent of the society in America.

A laboratory manual has been published by Prof. *Delos Fall*, of Albion, Mich., under the title *An Introduction to Qualitative Chemical Analysis*. It is intended to lead students to learn analysis by the inductive method. That this method of study "produces strong, accurate, enthusiastic, and independent students" is attested by the author's experience of several years with it. An introduction contains an outline of the mode of teaching for which the book is adapted; the tests are interspersed with practical hints and with questions that draw the student's attention to the essential features of what he is doing; lists of apparatus and reagents required are given, and also forms for recording the results, which to the student are discoveries.

The Legislature of the new State of Wyoming, in January, 1891, established the *Wyoming Experiment Station*, which, under date of May, 1891, issued its first *Bulletin*. This document describes the organization and the proposed work of the station. The arrangements for agricultural experiments include six farms, at altitudes from four thousand to seven thousand feet above sea-level, four fifths of the State being between four thousand and eight thousand feet. All but one of these farms are under irrigation. Special experiments on grasses are also being carried on under the direction of the U. S. Department of Agriculture.

Bulletin No. 33, New Series, of the *New York Agricultural Experiment Station* is devoted to fertilizers. It contains one paper that can not be too highly praised; this is an Explanation of Terms of Chemical Analysis. A great part of the literature of agricultural stations is made entirely useless for the farmers that are taxed to pay for it by the use of chemical and other technical

phraseology that only graduates of scientific schools can understand. Such explanations as the above should be multiplied.

A pamphlet with the title *Ethereal Matter; Electricity and Akasa*, has been made by *Nils Kolkin*, consisting of extracts from two books by the same author (J. M. Pinckney Co., Sioux City, Iowa, fifty cents). The subjects treated are the less known forces of Nature and various hypothetical substances, and the pamphlet will doubtless have interest for those who enjoy excursions into the unexplored domain of physics.

A stirring and practical address on *The Teacher as he should be*, delivered by *C. W. Bardeen* in July, 1891, has been published in a pamphlet (Bardeen, Syracuse, N. Y.). The drift of the address is that personality is of far more importance in a teacher than pedantically accurate knowledge on every subject.

A weekly magazine, called *Railway Law and Legislation*, and conducted by *W. P. Canaday* and *G. B. West*, began to appear in September, 1891 (712 Tenth Street, N. W., Washington, D. C., $3 a year). It is concerned with legislation, litigation, and financial and economic developments affecting common carriers. The first article is a historical sketch of The Nicaragua Canal Project. Other subjects treated are Canadian Competition and Discrimination, The Postal Telegraph Bill, The Coming Committees (a forecast), and various minor matters mentioned in notes.

Among the Miscellaneous Documents of the Fifty-first Congress was one entitled *Postal Savings-Banks; an Argument in their Favor by the Postmaster-General.* The reasons for adding the function of savings-banks to the post-offices are set forth in a communication of fifteen pages, and an appendix of seventy-two pages contains a proposed bill to establish postal savings-banks, details of such systems of banks in other countries, opinions of previous postmasters-general, a large number of press comments concerning postal savings-banks, and some minor exhibits.

The first number of a quarterly magazine, devoted to matters of interest to inhabitants of Kansas, was published at Salina, Kan., July, 1891 (C. B. Kirtland Publishing Company, $1 a year). It is called *The Agora*, and the contents of its first number include The Kansas "Mulligrub," by Hon. William A. Phillips; Imagination in Science, by Prof. L. E. Sayre; A New Sociology, by Rev. E. C. Ray, D. D.; "Bleeding Kansas," by Prof. J. W. D. Anderson; besides other articles, poetry, and book notices.

An Introductory French Reader, the object of which is to prepare the pupil in the shortest possible time to read French easily, has been prepared by *William Dwight Whitney* and *M. P. Whitney*, and is published by Henry Holt & Co. and F. W. Christern. The exercises have been selected, with this end in view, from the works of the best-known French authors, choosing such passages as are simple enough to present little difficulty in translation, and so varied and interesting as to rouse and hold attention. A full vocabulary, in which the ordinary idiomatic phrases and expressions in the text are explained, and a table of irregular verbs are added; while the grammatical difficulties and a few literary and historical points are treated in the notes. (Price, 70 cents.)

The A B C of the Swedish System of Educational Gymnastics is a practical handbook for teaching the subject, prepared by *Hartvig Nissen*, an experienced teacher of the exercise in the public schools of Boston, and published by F. A. Davis, Philadelphia. The first two chapters contain such questions as have been frequently put to the author, the answers to which give a satisfactory idea of the foundation of the system. Other chapters contain prescriptions for daily lessons, arranged for school classes of different grades. Full instructions and commands are given for each lesson, and the whole is illustrated by seventy-seven engravings. (Price, 75 cents.)

Mr. *Thomas Bertrand Bronson's* little manual of *Colloquial German* is designed to be a drill-book in conversation for school classes or self-instruction, and is intended to offer in convenient form a short course in that art and in German composition. It contains exercises in ordinary English conversation, which the student is expected to turn into German, to aid him in doing which a vocabulary, a summary of grammar, and a list of the irregular verbs are added. (Published by Henry Holt & Co. Price, 65 cents.)

PUBLICATIONS RECEIVED.

Annual Report of the Postmaster-General. Government Printing-Office. Pp. 183. With Maps.

Bacteriological World. Paul Paquin and J. H. Kellogg, editors. Battle Creek, Mich. Monthly. Pp. 40. $2 a year, 25 cents a number.

Bolton, H. C. Scientific Correspondence of Joseph Priestley. Pp. 240. With Portrait.

Butler. Amos W. The Birds of Indiana. Pp. 135.

Calendar for 1892. Styles & Cash. New York.

Carus, Paul. Homilies of Science Chicago: Open Court Publishing Co. Pp. 317. $1.50.

Chaddock, C. G. Visual Imagery of Alcoholic Delirium. Pp. 5. Reprint.

Commissioner of Labor. Annual Report for 1890. Parts I, II, and III. Government Printing-Office.

Cornell University Agricultural Experiment Station. Bulletin 33. Wire-worms. Pp. 82.

Engineering and Mining Journal. Mineral Statistics for 1891. New York: Scientific Publishing Co. Pp. 78.

Geikie, Archibald. Geological Sketches at Home and Abroad. New York: Macmillan & Co. Pp. 332. $1.50.

Green, C. H. Catalogue of a Unique Collection of Cliff-dweller Relics. Chicago. Pp. 35. 25 cents.

Hart, A. B. Epoch Maps illustrating American History. New York: Longmans, Green & Co.

Humanity and Health. Monthly. New York: Humanity Publishing Co. Pp. 14. $1 a year, 10 cents a number.

Hunt, T. Sterry. Systematic Mineralogy based on a Natural Classification. New York: Scientific Publishing Co. Pp. 391. $5.

Hutchinson, Rev H. N. The Story of the Hills. New York: Macmillan & Co. Pp. 357. $1.50.

Keller, Helen. Souvenir of the First Summer Meeting of the American Association to promote the Teaching of Speech to the Deaf. Washington: Volta Bureau. Illustrated.

Langley, S. P. Report of the Secretary of the Smithsonian Institution. Government Printing-Office. Pp. 63.

Lethaby, W. R. Architecture, Mysticism, and Myth. New York: Macmillan & Co. Pp. 272. $1 75.

Martin, G. H. Antidotes to Superstition. London: Watts & Co. Pp. 154.

New York State Reformatory. Sixteenth Yearbook. Illustrated.

New York and the World's Fair. Pp. 59. Illustrated.

Peirce, Dr. C. N. Sanitary Disposal of the Dead. Philadelphia Cremation Society. Pp. 57.

Philosophical Review. Bimonthly. J. G. Schurman, Editor Boston: Ginn & Co. Pp. 128. 75 cents a number. $3 a year.

Porter, Robert P. The Eleventh Census. New York: Engraving & Printing Co. Pp. 64.

Powell, J. W. Tenth Annual Report of the United States Geological Survey. 2 vols. Pp. 123 and 774. Government Printing-Office. Illustrated.

Report of Board of Engineer Officers, United States Navy, on Ward's Water-tube Marine Boiler, etc. Pp. 32. Illustrated.

Roads Improvement. Papers by Isaac B. Potter, Edward P. North, and Prof. Lewis M. Haupt. Pp. 30. Reprint.

School and College. Ray Greene Huling, Editor. Boston: Ginn & Co. Monthly. Pp. 64. 20 cents a number, $1.50 a year.

School of Applied Ethics. First Year's Work. Pp. 15.

Scott, Alexander. Introduction to Chemical Theory. London: Adam and Charles Black. Pp. 266. $1.25.

Shufeldt, R. W. Where Young Amateur Photographers can be of Assistance to Science. Pp. 5. Reprint. Illustrated.

Smithsonian Institution. Miscellaneous Papers. Some Observations on the Hevasu Pai Indians and The Navajo Belt-weaver. By R. W Shufeldt.—On the Characters of some Palæozoic Fishes. By E. D. Cope.—Condition and Progress of the United States National Museum. By G. Brown Goode.—The Genus Panopeus. By James A. Benedict and Mary J. Rathbun.—The Pito te henua, or Easter Island. By William J. Thompson.—Aboriginal Skin-dressing. By Otis T. Mason.—Animals recently Extinct, etc. By Frederic A. Lucas.—The Development of the American Rail and Track. By J. Elfreth Watkins.—Department of Geology, United States National Museum. By George P. Merrill. Government Printing-Office 1891.

Statistics of Railways. Part of Third Annual Report to the Interstate Commerce Commission. Government Printing-Office, 1891. Pp. 99. Advance sheets.

Texas Sanitarian. T. J. Bennett, Editor Monthly. Austin, Texas: Sanitarian Publishing Co.. Pp. 72. $2 a year.

Thornton, C. S. Report on the Condition of the Cook County Normal School. Chicago. Pp. 27.

Trimble, Henry. The Tannins. Philadelphia: J. B. Lippincott Co. Pp. 168. $2.

United States Geological Survey Bulletins No. 62, 65, 67 to 81, inclusive. Government Printing-Office, 1890 and 1891.

Wright, G. Frederick. Theory of an Interglacial Submergence in England. Pp. 8. Reprint.

Wyatt, Francis. The Phosphates of America. New York: Scientific Publishing Co. Pp. 187. $4.

POPULAR MISCELLANY.

A Defense of Examinations.—Examinations are defended by W. H. Maxwell, in a paper which he read before the National Education Association at its meeting in 1890. To the question, "Is examination one of the means that occasion those mental activities which result in knowledge, power, and skill?" Mr. Maxwell gives an affirmative answer, saying: "Knowledge is not knowledge when it has been merely taken in. It is not knowledge until it has passed through the mind and come out again in words or actions of our own. Until this is done, we can not be sure even that we possess knowledge. Every thorough-going student has been at some time or other, when confronted with examination questions, amazed at his own ignorance of subjects with which he fondly imagined he was thoroughly familiar. There is probably no better test of a teacher's ability than his power to determine, during the giving of a lesson or after it has been given, whether it has been mastered by his pupils. And yet I have frequently seen teachers of great ability astonished at their pupils' ignorance of subjects which they (the teachers) thought had been completely

mastered. In all these cases the examination test proves that the knowledge in question has not been assimilated, has not been converted into faculty. The very act of reproducing knowledge in the pupil's own words or acts is one of the best means of converting it into faculty; but it is not the only means. The process is not complete when isolated facts, nor even when divisions of a subject, have passed through the mind and been reproduced. All this is necessary, but it is not enough. It is but a means to an end, and the end is the comprehension of a subject as a whole, and the comprehension of the relations of the various parts to one another and to the whole. . . . Nor is even this all. The process of learning is not complete till the pupil can apply his knowledge in some practical way. . . . Examination consists not merely in reproducing knowledge imparted or acquired, but in making practical application of knowledge, in testing power and skill. And hence on this ground also—the ground of practical application as well as that of reproduction—examination, seeing that it is not only a test of application and reproduction, but an exercise in application and a means of the development of power and skill, must be regarded as an element of teaching what is good."

Climate and Health.—The modifying effects of differences in age deserve more attention than they have received in the discussion of the influence of climate upon health. The question is a practical one, and admits, according to the Lancet, of some fairly definite rules and principles. In general, children respond more readily to change than older persons. They commonly do well at the seaside; they often benefit signally by a sea-voyage, and do not suffer severely from the discomforts attending one. They suffer more than grown people from the depressing influences of city life; and, in a large proportion of cases, they are not specially benefited by the climate of high altitudes. The explanation of the love of children for the sea is that they are benefited by it, because they are commonly in a condition to bear stimulation, not having used-up nervous systems. They are attracted by the sea and its products, and by the amusements natural to the seaside; and some of their most common ailments are among the affections most amenable to sea influences. The advantages of mountain air to them are not so conspicuous, but much has yet to be learned on this subject before it can be discussed with full intelligence. Elderly people in general do well with equability and moderate warmth, bear cold badly, and are most benefited by abundant sunshine. High altitudes are rarely suitable to them, and often injurious; and they do best in level places, where there is abundant shelter. They may or may not benefit by the seaside or a sea-voyage, but these measures can not be recommended with the same confidence as to children. In nothing is the superior recuperative power of youth over age more apparent than in the greater readiness and certainty of its response to change of climate. We can confidently recommend to the young measures which we suggest dubiously to the old. In fact, change is rarely at fault in the earlier years of life, whereas it is often a doubtful and sometimes a hazardous experiment for the aged. In the case of the old, we need to have solid reasons and tolerably definite prospects before we induce them to give up the comforts and safety of home for the uncertainties of travel.

The United States Life-saving Service.—Systematic methods for the preservation of life from shipwreck were not adopted till very late in history. According to Mr. Horace L. Piper, of our Life-saving Service, the eighteenth century was "well in its twilight" before any organized effort, and that private, was made for this purpose. The first life-boat was not invented till after our independence was achieved, and George Washington had been two years President when the first serious steps in that direction were taken in England. The United States was abreast of other countries in this work. The Humane Society, organized in Massachusetts in 1786, devoted itself to it in 1789. The Life-saving Service of the United States was begun in 1848, was made more effective in 1871, and was organized into a separate bureau in 1878. For its purposes, the coasts of the Atlantic, the Gulf of Mexico, the Great Lakes, and the Pacific (excepting Alaska), comprising more than ten thousand miles, are

divided into twelve life-saving districts, designated by number, beginning with Maine on the Atlantic and ending with Washington on the Pacific. Each district is in charge of a superintendent chosen for his knowledge of the subject, business capacity, and executive ability. The districts are subdivided into stations, known by the names of their localities, and situated with regard to the special dangers of the coast. They are of two kinds: complete life-saving stations, and houses of refuge. In all there are about two hundred and forty stations of both kinds, but some of them are not yet fully completed and manned. A majority of them are on the Atlantic coast: ten on the shores of Maine and New Hampshire; six in Massachusetts, where the Humane Society provides whatever other service is needed; thirty-nine on Long Island; forty in New Jersey; seventeen between Cape Henlopen and Cape Charles; twenty-three between Cape Henry and Cape Hatteras; one station and ten houses of refuge in Florida; eight on the Gulf of Mexico; forty-nine on the Lakes; and twelve on the Pacific coast. Every station is in charge of an officer who is really the captain of the crew, but whose technical designation of keeper is a survival from the time when only one person was constantly employed and depended on volunteers for help. The crews are technically known as surfmen, and are selected by the keeper from the best men in the neighborhood. The crews are under the control of the keepers, and above these are the district superintendent, who visits the stations quarterly; the assistant inspector, who makes monthly rounds; and the general inspector, who reports periodically to headquarters in Washington. The statements of the operations of the service show that it has been very effective in saving life and property. The entire loss of lives on all the coasts of the United States under the present system since 1871 has been only thirty-eight in excess of the loss on the Long Island and New Jersey coasts alone during the preceding twenty years. This efficiency is largely due to the fact that politics has not yet intruded into the service, while the principle of choosing and keeping the best men for their work has been steadfastly adhered to.

Organic Variation a Chemical Problem.—The laws of chemism are applied by Prof. A. E. Dolbear to explain the phenomena of protoplasmic growth and change. Since the discovery of the mechanical equivalent of heat there has been no alternative but to suppose those phenomena to be due to motion. Having shown that such motions of matter as constitute sound, heat, magnetism, and the rest, all produce fields external to themselves, and that within such fields other bodies are brought into similar states of position or of motion or both, the author would apply the same principle to protoplasm and cell structure. "Imagine a cell with any degree of complexity, surrounded by material such as it is itself composed of, and what should one look for to take place if not that the same kind of a structure should be reproduced? When this happens, we say growth has taken place, and it is attributed to life. As the new cell is similar to the old one that furnished the specific conditions for its development, we say it has inherited its form and functions. The bearings of this upon the fundamental problems of biology are apparent. If the foregoing be true, heredity is explained as much as inductive magnetism is, and is no more mysterious. . . . Suppose that in such a complex molecule as protoplasm a single atom of a different substance should accidentally become imbedded, either as a constituent or not, it would bring its field along with it necessarily, and the resultant field of the whole would be modified. It could not be what it would be in the absence of this new constituent, and consequently the reaction upon other matter in its neighborhood would be different, and the next organic molecule formed would need to be a little differently organized. Mechanical conditions would necessitate it. Again, if energy, radiant or conducted, should act for a short time upon one part of a molecule, it might easily bring about an exchange of positions among some of the less stable constituents without other disturbance, and this too would result in a change of the configuration of the field and the direction of growth. Every change in the collocation and motions among molecules exhibits itself in changed properties. Such conditions might properly be spoken of as changes in the environment, but it is mo-

lecular environment, and the difference between this idea and that heretofore common is, that the molecule produces an environment of its own—the space beyond its own geometric boundary, in which it is competent to act upon other bodies and compel other bodies to conform in a greater or less degree to it. More than that, a new constituent in a nearly saturated molecule could not have as firm a grip upon the structure as the older constituents could have, although it might so modify things while present as to organize other molecules in like manner, but slight changes in the neighborhood might slough off the new acquisition in a subsequent generation, so there might be a return to the form and qualities of the ancestry—that is, reversion to a former type would also be a mechanical consequence. Thus growth, heredity, variation, and reversion may be considered as the consequence of atoms vibrating in harmonic orders, each producing its own field in the universal ether, and each group of atoms constituting a molecule, large or small, having a field which is the resultant of all the fields of its constituents. All of them are molecular properties as much as any one of them can be, and growth has been believed for a long time to be a property of inorganic molecules. The cause of variation is therefore molecular as truly as isomerism is a different collocation of atoms. It is a chemical problem."

Snake-myths.—A great deal of nonsense has been published, and a great deal more is believed, about snakes. Some most thrilling stories turn upon a power which serpents are credited with of fascinating their victims. This appears to be a superstition. According to Mr. Vincent Richards, mice, birds, dogs, guinea-pigs, and other small animals, introduced into a rattlesnake's cage, show little fear, even at first, and afterward none whatever. Smaller birds, after fluttering about till they are tired, end by becoming amusingly familiar with the snakes. Mr. Richards put two rats into a cage containing forty cobras. At the outset the rats' appetites were considerably affected, and they were evidently alarmed. In a short time, however, they recovered their spirits, and caused considerable commotion among the cobras by running all over their heads and bodies. The snakes resented this familiarity by darting at each other and at imaginary foes. The rats lived and partook of food in the cage for ten or twelve days, when, one after another, they were found dead — "victims, no doubt, of misplaced confidence." It is still a matter of debate whether snakes are proof against their own poison. The remedies advised for snake-bite are of doubtful validity. Because a man recovers after being bitten by a snake, and dosed with opium, mercury, ammonia, or what not, we must not jump to the conclusion that the treatment has effected a cure. A snake may bite without poisoning. Biting, though in appearance simple enough, consists really of a series of complex movements, following rapidly one upon another in ordered sequence, should any of which be inadequately performed, the victim may not be properly poisoned. Ammonia, alcohol, and making the patient move about, are worse than useless; for they increase the activity of the circulation, and thereby promote the absorption of the poison. Even permanganate of potash is of no effect unless it is administered within four minutes. Researches into the nature of the poison have shown that it resides in some proteid, and that there are three toxic elements—globulin, serum albumen, and acid albumen—but wherein the quality consists that gives to these substances, usually so harmless, their poisonous power, is as much in the dark as ever.

The Gems of the Ancients.—The gems of the ancients, according to Prof. J. H. Middleton's book on the Engraved Gems of Classical Times, consisted chiefly of the varieties of quartz—including colorless rock crystal, amethyst, sard, carnelian, chalcedony, chrysoprase, plasma, jasper, onyx, and sardonyx. Among the non-silicious stones were chrysoberyl, topaz, emerald, garnets, peridote, turquoise, opal, and lapis lazuli. The translucent stones are preferred, for artistic purposes, to the transparent ones. They admit the light, but not the forms of objects, and better reveal the charms of fine and noble workmanship. Many "gems" have been wrought or reproduced in paste and glass. Paste was a hard glass colored by various metallic oxides, such as those of manganese, iron,

copper, and cobalt. Sometimes a piece of paste was treated by the gem-engraver just as if it were a natural stone, and sculptured by the aid of the same tools; but more generally the glass was melted and pressed into a mold. Such a mold had been taken from an engraved gem by a pellet of clay which was afterward hardened by fire. Paste gems are often beautiful in color and design, though the material lacks something of the optical properties which distinguish many of the true natural stones. The tools and processes employed in ancient times in engraving gems were virtually the same as those in use to day—drills, wire saws, and files, re-enforced with emery, and gravers of diamond, sapphire, or rock-crystal.

Courtship in Torres Strait.—The people living on the islands of Torres Strait are divided by Prof. Arthur C. Haddon into the eastern and western tribes, and customs differ considerably among them. While the usual course in marriage is followed by the eastern tribe, in the western tribe the girls propose—or did, till "civilization" overtook them—marriage to the men. "It might be some time before a man had an offer; but should he be a fine dancer, with goodly calves, and dance with sprightliness and energy at the festive dances, he would not lack admirers. Should there still be a reticence on the part of his female acquaintances, the young man might win the heart of a girl by robbing a man of his head. Our adventurous youth could join in some foray; it mattered not to him what was the equity of the quarrel, or whether there was any enmity at all between his people and the attacked. So long as he killed some one—man, woman, or child—and brought the head back, it was not of much consequence to him whose head it was. . . . The girl's heart being won by prowess, dancing skill, or fine appearance, she would plait a strong armlet, *tiapururu*; this she intrusted to a mutual friend, preferably the chosen one's sister. On the first suitable opportunity the sister said to her brother, 'Brother, I have some good news for you. A woman likes you.' On hearing her name, and after some conversation, if he was willing to go on with the affair, he told his sister to ask the girl to keep some appointment with him in the bush. When the message was delivered, the enamored damsel informed her parent that she was going into the woods to get some wood or food, or made some such excuse. In due course the couple met, sat down and talked, the proposal being made with perfect decorum. The following conversation is given in the actual words used by my informant, Maino, the chief of Tud. Opening the conversation, the man said, 'You like me proper?' 'Yes,' she replied, 'I like you proper with my heart inside. Eye along my heart see you—you my man.' Unwilling to give himself away rashly, he asked, 'How you like me?' 'I like your fine legs, you got fine body—your skin good—I like you altogether,' replied the girl. After matters had proceeded satisfactorily, the girl, anxious to clinch the matter, asked when they were to be married. The man said, 'To-morrow, if you like.' They both went home and told their respective relatives. Then the girl's people fought the man's folk, 'for girl more big' (i. e., of more consequence) 'than boy'; but the fighting was not of a serious character, it being part of the programme of a marriage. 'Swapping' sisters in matrimony was a convenient way of saving expense in the way of wedding gifts, for one girl operated as a set-off to the other."

Value of Photography.—The name of impressionists has been given to a school of painters who, abandoning all consideration of the arrangements and mechanism of previous workers, have consulted only their impressions of natural scenes, and have painted to those impressions. "With one point of sight and one subject of supreme interest they have aimed to seize above all the action and first impression of that subject." The naturalistic school trust rather to a study of Nature, and make its truthful representation and perfect expression the criterion of their art. Mr. George Davison sees no reason why photography should not be used to express our impressions of natural scenes as well as any other black-and-white method. Worked under the same conditions as the eye, or under conditions as nearly approximate as possible, nothing, he says, gives so truthful a record in drawing as photography, and nothing, when the proper means are used and the requisite knowledge is possessed by the

photographer, gives so delicately correct a relation of tones. It is to the proper use of the proper means at their disposal that photographers need stimulating. The most important of these means are such as are directed to securing the proper light effect and relations of light values, and those which give the focusing and relative interests of the subject. Some of the simplest facts of light are overlooked by photographers, who have been governed by untrue and misleading conventions and dogmas concerning gradation and brilliancy. Instead of deep black prints usually in favor among them, it is of first-rate importance in landscape pictures to keep the shadows light. To repeat the impression of outdoor light the whole picture must be luminous, and not heavy and dark, as is the effect of the ordinary style. Further, the shadows when the sun shines are lighter than when he is obscured. The printing medium employed is an important consideration. Mr. Davison finds excellent qualities in the newest extra rough-surfaced papers. Photography is good under suitable conditions of light for representing transient action and effects. Photography has preeminently more of painting qualities than any other monochrome process. It is not specially limited to nor compelled to emphasize facts of form. It gives form by means of tone against tone—the best means of rendering it—and its truth of form is unlimited. It is equal to any other black-and-white process. In nothing more than closed forms is the delicacy of its tonal discriminations shown. The quality of naturalness will tell in the long run. Men will weary of emphasis, and graphic artists will leave past history, archæology, and fiction to literature or scientific drawing.

A Voodoo Initiation.—A paper was communicated to the International Folk-lore Congress in London by Miss Owen on Voodoo Magic, to the mysteries of which she alone among white women had been initiated. The ceremony of initiation began with a walk at midnight, barefooted and bareheaded, to a fallow field. The author had to walk backward to the field, and when there, to pull up, with her hand behind her, a weed by the roots. She was then bidden to run home and throw the weed under her bed, to be left there till sunrise. Next, the weed had to be stripped of its leaves and made into a little packet, to be worn under the right arm for nine days. At the end of this time the leaves of the packet had to be scattered to the four winds, a few being thrown at a time over the right shoulder as the novice turned round and round, so that they might fall north, south, east, and west. When this was done the novice was ready for instruction. She learned that the preeminently lucky number which, when woven into incantations, was irresistible, was four times four times four; while ten was the unlucky number. After this a knowledge of the value of certain vegetable remedies and poisons had to be acquired. Charms were divided into four degrees. The first were good charms, the hardest to work, because good is always more difficult to practice than evil; the second were bad charms and fetiches made in the name of the devil; the third had special reference to bodily ailments; and the fourth related to what were called "commanded things," such as earth and pieces of stick. After each lesson both pupil and teacher had to get drunk, either by drinking whisky or by swallowing tobacco-smoke. To be thoroughly equipped the novitiate must possess a conjuring-stone—a stone black, kidney-shaped, and very rare. These stones were supposed to operate most rapidly when the moon was full or just beginning to wane. At other times, if the stones were not efficacious enough, their potency could be stimulated by a libation of whisky.

Cremation in Japan.—We are indebted to a correspondent of the London Spectator for the following interesting account of this method of disposing of the dead in Meguro, Tôkeigô. It appears that cremation is the general custom among the "Monto sect of the Buddhists," a highly enlightened branch of Japanese Buddhism, which holds to the immortality of the soul as one of its leading tenets. "The building is of plaster, with an earthen floor, with stone supports for bodies. The chimneys are wide, and are carried to a considerable height, and there is no escape of disagreeable effluvium over the neighborhood. The bodies in the ordinary wooden chests which are used for burial are placed

upon piles of fagots at 8 P. M., and are *totally* consumed by 6 A. M. The relations are admitted early in the morning, and the ashes are collected and placed in urns. The scale of charges is 3*s.* 6*d.*, 7*s.* 6*d.*, 15*s.*, and 20*s.*, the process in each case being the same, the only difference being that the highest charge insures a solitary chamber, while for the lowest the corpse may be consumed in company with five others, each, of course, occupying a separate stone platform."

Chinese Cookery.—It appears, from the Pall Mall Budget, that the great number of strange dishes spoken of in books of travel are seen only at official banquets, and do not constitute the meals even of the wealthy Chinese. These public dinners are usually given in restaurants, which are built two or three stories high, the kitchen and public rooms being on the first floor, the private rooms above. A correspondent of the Journal des Débats gives the following as the bill of fare at a banquet given by a French official of the Chinese Government to Chen Pao-Chen, the Viceroy of the Two Kiangs: "Four large 'classical' or stock dishes—swallows'-nest soup with pigeons' eggs, sharks' fins with crabs, trepang (*bêche de mer*) with wild duck, duck with cabbage. Dishes served in cups placed before each guest—swallows' nests, sharks' fins, wild cherries, vegetables, mushrooms with ducks' feet, quails, pigeons in slices, dish of sundries. Four medium-sized dishes—ham and honey, pea-soup, vegetables, trepang. Four large dessert dishes—pea-cheese with bamboo roots, bamboo roots, chicken, shell-fish; four dishes of dried fruits as ornaments, four kinds of dry fruits, four kinds of fruits in sirup, four kinds of fresh fruit; four dishes of *hors d'œuvre* (two varieties in each dish)—ham and chicken, fish and gizzard, tripe and vermicelli, duck and pork chops. Dishes set before each guest—almonds and watermelon pips, pears and oranges. Sweet and salt dishes served in cups set before each guest—two kinds of salted cakes, ham-broth, a broth composed of pork, chicken, and crab boiled down, two sweet cakes, a cup of lotus fruit, a cup of almond milk. Roast and boiled meats—sucking pig, roast duck, boiled chicken, boiled pork. *Entremets*—a dish of cakes with broth, slices of pheasants. Last service—mutton broth, almond jelly, white cabbage, pork and broth, bowls of rice, cups of green tea." Notwithstanding this elaborate "bill of fare," the Chinese are generally an abstemious people. A coolie will subsist upon eight shillings a month, and live comfortably upon twice that sum. Boiled rice is the staple article of food. In the north of China wheat and canary seed, boiled and made into small rolls, are much used. Small cakes made of boiled wheat, together with a little fish or some vegetables, constitute an excellent dinner for a Chinaman. Some light refreshment is frequently taken between meals by the well-to-do Chinaman—"the kuo tsâ leading up to the morning, the kuo tsong to the midday, and the tien chen to the evening meal, while the chian ya and the kuo yia are partaken of during the night by those who can not get to sleep."

A Defense of Opium-smoking.—That there is no cause without its advocate is evident from the fact that Consul Gardner, in a trade report for the past year, plausibly defends the practice of opium-smoking. We gather the following from the Pall Mall Budget: About 12,000,000 pounds of opium are yearly consumed in China. The smokers are of three classes—occasional smokers, habitual moderate smokers, and excessive habitual smokers. When a Chinaman is said to smoke opium, the recognized meaning is that he belongs to the third class, just as with us when we say that a man "drinks," excessive drinking is understood. In smoking, only part of the drug is consumed; the ash when reprepared yields fifty per cent of opium. This accounts for the fact that the saloon-keepers sell opium at what appears to be cost price; the ash yields the profit and pays for light, house-rent, and attendance. It is estimated that the immoderate smoker consumes not over four pounds a year, and the average annual consumption of all classes is half a pound. If, as this implies, half the adult population smoke, and opium-smoking is the evil it is represented to be, why are there not visible inherited ill effects? Consul Gardner, in reply, says: "The length of the intestines in man shows that a due admixture of animal and vegetable food is the diet best suited

to him. In China the population lives almost entirely on vegetables. Opium-smoking slows the processes of digestion, and, in fact, has the same effect as long intestines, and consequently is highly beneficial." Again, the Chinese live in low, undrained grounds, and are consequently liable to attacks of fever and ague. Under similar circumstances the lowlanders of Lincolnshire took to laudanum; the Chinese take opium in another form. Residents in China are struck with the comparative freedom of the people from pulmonary diseases. "That this immunity is not due to climatic influences is clearly proved by the fact that Europeans and Americans are not more free from the scourge in China than they are in their own countries." Morphia is an anæsthetic, and rarefied as smoke probably an antiseptic. "In this form it would tend to arrest the suppuration of the lungs that takes place in consumption."

Oscillations of Alpine Glaciers.—About thirty years ago, according to Herr von E. Richter, the glaciers of the Alps began a precipitate retreat. In 1870 the traveler often found a stone-strewn plain or an undulating slope of polished rock where ten years before he had scrambled over crevassed ice. About five years later, a slight, transitory forward movement was perceptible, while now the indications of an advance are becoming more marked. Similar changes, at earlier dates, are on record, and their history has been studied by Prof. Forel, Herr von Richter, and others. The historical period of the oscillations of the glaciers extends back about three centuries, while prior to this the notices are too sparse and vague to be of any real use. In this period eight marked epochs of glacier growth are on record. The first began in 1592, and the last, excluding the slight one of 1875, in 1835. Each was followed by a period of diminution. The intervals between the epochs vary from twenty to forty-seven years. The observations are not numerous enough to give trustworthy indication of a law, but are supposed to hint at one. The changes are connected with climatic variations, but effects are produced more quickly than is generally supposed. In the present century the curves representing the oscillations of the glacier and those of the annual temperature nearly correspond. Some traditions assert that in the middle ages the glaciers had almost melted away from many parts of the Alps, and passes were then crossed by women and children which are now left to experienced mountaineers. Their evidence relates to the cultivation of vines, cereals, etc., in localities where they are no longer grown, and to the former use of passes which are now practically closed. To the former evidence, as Herr Richter shows, little weight can be given. Man and Nature are in constant conflict in the Alps, and the position of the frontier line between their territories is determined by the convenience of the former. If a particular form of cultivation ceases to be remunerative all the advanced posts are abandoned. Herr Richter, likewise, does not give much force to evidence based on the disuse of passes. This is more than likely to have been brought about by the discovery of better ways or the making of new roads. In short, says the Saturday Review, under this author's treatment, "the traditions, not the glaciers, become unsubstantial, and the warm epoch in the mediæval history of the Alps goes the way of many other legends."

Origin of the Colors of Flowers.—Any one, says Mr. E. Williams Hervey, in Garden and Forest, can solve the problem as to the primitive color of flowers by a study of the native wild plants growing by the roadside or in the fields and woods. Two methods, he says, are employed by Nature in the development of colors, one of which he calls the imperfect or foliar development, and the other the normal floral process. In the former, the colors are apparently evolved directly from the green chlorophyl, as the reds, purples, and yellows of autumn leaves; for from some green-colored flowers a rather limited number of dull reds, purples, and yellows are produced. The reds and reddish purples are, however, rare, and appear mostly on the scales of involucres, where they are common, on the spathes of several of the *Araceæ*, in *Salicornia* of the salt marshes, which turns red in the fall, and in the castor-oil plant of gardens, which turns a reddish purple in all its parts. The author does not find a satisfactory example of yellow evolved

directly from green among our native plants, and doubts if any pure yellow ever immediately succeeds green. But there are some greenish-yellow flowers. For illustration of the normal floral method of development by which he believes all the bright, attractive hues of the floral world are produced, the author takes up the *Spiranthes gracilis*, or ladies-tresses, an orchid which grows in all our fields, having small white flowers spirally disposed at the summit of the scape. The lip is green, fringed around the edges with white, and the other petals are wholly white. "A small section of the petals, placed under the magnifying glass, appears colorless and transparent, while the delicate network of the tissue glistens like crystal; yet this colorless tissue, in a mass, reflects white. In the same manner a single leaf-like bract of *Monotropa uniflora*, severed from the stem, appears colorless; but two or more placed together, making a greater thickness, reflect a decided white color." Attention is called to the fact that in *Spiranthes* the white color directly succeeds the dark rich green of the lip. The author then endeavors to demonstrate that the universal law of progression in color, as regards the floral structure, is first from green to white; "or, differently stated, Nature, before she begins to paint the more rich and delicate tissue of the petals, by some secret chemical process completely eliminates the chlorophyl and prepares a perfectly pure and white canvas upon which to essay higher flights of fancy." Twenty-eight wild and garden flowers are cited as illustrating this principle in the development of their colors, and numerous inconspicuous or weed-like plants in the coloring of their sepals; while the hues of flowers of other colors are thus produced by transition through white, "without a single exception every flower that came to hand of a white color was developed directly from green, without any intervening color."

Canaries.—A correspondent of the London Spectator writes chattily of his pet canaries, and seems to show that they are very human in their reason and unreason. During some intensely hot weather, when the hen was sitting, she drooped, and it seemed as if she might not be able to hatch her eggs. The cock, however, showed himself an excellent nurse. After bathing in fresh cold water, he went every morning to the edge of the nest and allowed the hen to refresh herself by burying her head in his breast. A green and yellow canary hung side by side, and were treated exactly alike. One day three dandelion blossoms were given to the green bird and two to the yellow one. The latter showed his anger at the proceeding by "flying about his cage, singing in a shrill voice." But when one of the three flowers was taken away, both birds seemed quietly to enjoy their feast.

Utilizing the Less-known Metals.—In closing his presidential address before the Chemical Section of the British Association, Prof. Roberts-Austen spoke of the great importance of extending the use of the less-known metals. He supposed that in the immediate future there would be a rapid increase in the number of metallurgical processes that depend on reactions which are set up by submitting chemical systems to electrical stress. Attention is at present concentrated on the production of aluminum. Sodium, also, is of growing importance, both for cheapening the production of aluminum, and as a powerful weapon of research. The manufacture of magnesium, which was a curiosity in 1849, has become an important industry. We may confidently expect to see barium and calcium produced on a large scale as soon as their utility has been demonstrated by research. Minerals containing molybdenum are not rare; and the metal could probably be produced as cheaply as tin if a use were to be found for it. The quantities of vanadium and thallium which are available are also considerable; but we as yet know little of the action when alloyed of those metals which are in daily use. The field for investigation is vast, for it must be remembered that valuable qualities may be conferred on a mass of metal by a very small quantity of another element. The useful qualities imparted to platinum by iridium are well known. A small quantity of tellurium obliterates the crystalline structure of bismuth; but we have lost an ancient art, which enabled brittle antimony to be cast into useful vessels. Two tenths per cent

of chromium increases the strength of gold enormously, while the same amount of bismuth reduces the tenacity to a very low point. Chromium, cobalt, tungsten, titanium, cadmium, zirconium, and lithium are already well known in the arts, and the valuable properties which metallic chromium and tungsten confer upon steel are beginning to be generally recognized.

NOTES.

The Electrical Engineer begins the new year with the publication of the first of a series of articles on the electrical and magnetic discoveries of Prof. Joseph Henry, by his daughter, Miss Mary A. Henry, of Washington, with notes by Mr. Franklin Leonard Pope. Additional interest is given to these articles by the fact that the author will endeavor in them to substantiate the claim that Prof. Henry was the original discoverer of magneto-electricity.

A German physician, Dr. Krug, claims that he has discovered how to make an eatable and nutritious cake with wood. His method consists in transforming the cellulose into grape sugar, a substance assimilable by the animal organism. The biscuit is made by adding to this about forty per cent of meal of wheat, oats, or rye. Phosphates and all the bone elements may also be introduced. This bread of wood-glucose is intended to be fed to cattle, for which it will take the place of oil-cakes and other feeds composed of industrial wastes.

The Council of the School of Mines in England has determined that the room at South Kensington containing the library of research presented by Prof. Huxley to the institution, and in which he taught for nearly twenty years, shall be entirely set apart as the Huxley Laboratory for Biological Reseach. An endowment of one thousand pounds bequeathed for the establishment of a prize or scholarship in biology, has become available, together with the scientific books and instruments, and its proceeds will be appropriated annually in aid of a student in this laboratory, which now has provision for two students.

Mr. Albert Koebele, of our Bureau of Entomology, who is studying the enemies of insect pests in the Australasian colonies, was recently introduced by Sir James Hector to the Wellington Philosophical Society, New Zealand, as a naturalist whose work in securing the Vedalia lady-bird to destroy the Iceria pest of the California orchards is "one of the grandest things in the interest of fruit and tree growers that have been effected in modern times."

A correspondent of the Geneva (Switzerland) Tribune relates that his family were disturbed one evening by a mysterious ringing of the electric bells all over the house. Investigating the cause, the writer found that a large spider had established itself at a point where the bell and the electric light wires ran close to one another, with one leg on either wire, thus establishing a connection.

A specimen of prehistoric hatchets of peculiar form was exhibited by M. Villanova, of Piera, at the meeting of the French Association. About two hundred of them had been found at Elcho. They were simple emblems or images of a hatchet, made of a thin blade of metal, ornamented on both sides from one end to the other, and without edges. At the top is a kind of cup suggesting a socket that does not exist, and representing, probably, the jet of the casting.

Java is said to be the region of the globe where it thunders oftenest, having thunderstorms on ninety-seven days in the year. After it are Sumatra, with eighty-six days; Hindustan, with fifty-six; Borneo, with fifty-four; the Gold Coast, with fifty-two; and Rio de Janeiro, with fifty-one. In Europe, Italy occupies the first place, with thirty-eight days of thunder, while France and southern Russia have sixteen days, Great Britain and Switzerland seven days, and Norway only four days. Thunder is rare at Cairo, being heard on only three days in the year; and is extremely rare in northern Turkistan and the polar regions. The northern limit of the region of thunderstorms passes by Cape Ogle, Iceland, Nova Zembla, and the coast of the Siberian Sea.

A prize of four hundred kronen is offered by the Royal Danish Academy of Sciences at Copenhagen for investigations on the exact nature and proportions of the more important carbohydrates present, at different stages of maturity, in the cereals in most general use.

The use of aluminum is recommended by Mr. G. L. Addenbrooke, instead of brass, for the framing of photographic lenses and the metal parts of cameras; for the revolving tripod heads fixed in the base-boards of cameras; and for developing dishes, for which he regards it as very suitable, for the action of most of the chemicals used in photography is very slight upon it, and, when there is any, the compounds formed would not be harmful.

In the course of an account of various marriage customs, Dr. A. H. Post refers to a strange sort of symbolical marriage with plants, trees, animals, or inanimate objects, which is supposed to have originated in India. If any one proposes to enter upon a union that is not in accordance with traditional ideas, it is believed that the ill luck which is otherwise sure to follow may be

averted by a marriage of this kind, when the evil consequences will pass over to the object chosen. In some regions a girl must not marry before her elder sisters, but in parts of southern India the difficulty is overcome by the eldest daughter marrying the branch of a tree. Then the wedding of the younger daughter may be safely celebrated.

Facts well known to boys who are familiar with the woods are reported by Mr. C. Fitzgerald in The Zoölogist. During many winters passed in the backwoods of North America, he has seen squirrels frisking among the trees in the coldest weather. On bright, sunny days especially, they delight in chasing one another from tree to tree among the evergreens, and cover the snow with their tracks. The chipmunks lay up in the autumn a store of provisions of grain, nuts, etc., for winter, and may be seen sunning themselves on bright days. Mr. Fitzgerald has on several occasions come across their hoards, and once saw two large bucketfuls of shelled buckwheat taken from the hollow of an old birch tree.

Fruit-trees are planted along the roadsides of several countries of Europe, but it has not been usual to attach great importance to the value of their products. Recent estimates made in Germany show that this is considerable. The roadside trees of Hanover gave a gross return in 1890 of 270,000 francs, of which 187,000 francs were derived from the fruits. The roadside fruits of the Hildersheim region returned 64,000 francs, and those of Göttingen 41,000 francs; and the district of Reutlingen, according to the *Gartenflora*, derived 333,000 francs from the sale of these fruits. The trees of the Monheim district, first planted in 1858, yielded 9,500 francs in 1868, 22,000 francs in 1878, and about 36,000 francs in 1888.

Old newspapers are said to make valuable anti-moth wrappers for furs and winter clothing, the ink upon them being nearly as repulsive to all kinds of vermin as camphor or coal-tar paper. They are likewise good to lay on carpets for a like purpose. Being impermeable to air, they also form excellent envelopes for vessels containing ice and fresh liquors.

Garden and Forest tells the story of two famous trees which were saved from destruction, each by the sagacity and liberality of a man who appreciated their value. One is the giant Manzanita (*Arctostaphylos manzanita*), of St. Helena, Cal., which a woodchopper in the employ of the Napa Valley Wood Company had begun to cut down when Dr. C. Hitchcock, passing by, paid two dollars to have it saved. The other is the fine red oak of Dedham, Mass., which Thomas Motley, father of the historian, who owned the adjoining place, paid its owner to have spared. Both of these trees are now owned by men who will preserve them. The names of the men to whom their continued life is due deserve to be remembered.

OBITUARY NOTES.

Our French papers bring news, with no particulars, of the death, January 12th, of M. A. de Quatrefages, the eminent anthropologist, at the age of eighty-two years.

M. Jean Servais Stas, the distinguished Belgian chemist, died at Saint-Gilles, near Brussels, December 13th, after a short illness. He was born at Louvain in 1813, studied in Paris under Dumas, and, returning to Belgium, became a professor in the Military School. He was afterward Commissioner of Moneys, a member of the Commission of the Observatory, and, after the death of Houzeau, of the Committee of Direction, Belgian representative in the International Committee of Weights and Measures, member of many learned societies at home and abroad, and bearer of many honors. His chemical researches were numerous, and have been much quoted from.

Dr. H. K. H. Hoffmann, Professor of Botany at Giessen, and Director of the Botanic Institute there, died October 27th, in the seventy-third year of his age.

Edouard Mailly, formerly aid at the Royal Observatory of Belgium, died October 8th, in his eighty-second year. He entered the Observatory as a computer in 1832, and occupied himself there with the reductions of the meridional observations. He published in the Annuaire of the Observatory, and in the Academical Collections, a number of works in the history of science which were highly prized. Among them were essays on the Scientific Institutions of Great Britain and Ireland, Spain, Italy, and the United States, a sketch of Astronomy in the Southern Hemisphere and in India, papers on the history of the Belgian Academy, biographical notices of Adolphe and Ernest Quetelet, Van Ries, and Argelander, and a book of reminiscences.

The Right Rev. Harvey Goodwin, Bishop of Carlisle, who died in York, England, November 25th, took a prominent part in the discussion of questions involving the interrelations of science and religion. Being an eminent mathematician, as well as a distinguished theologian, he enforced his arguments with mathematical methods and principles, which added greatly to their effect. He was clear, judicious, and temperate in argument, and rarely missed the essential point. The papers by him which have been published in the Monthly attest his ability in this particular.

Prof. Joseph Lovering, Hollis Professor Emeritus of Harvard College, died January 18th of heart-failure following grip, in the seventy-ninth year of his age. A full sketch of his life and scientific activity till his retirement from work in 1888 was published in the Monthly for September, 1889.

CONSTANTINE SAMUEL RAFINESQUE.

For Sketch, see Vol. XXIX, p. 212 (June, 1886).

THE

POPULAR SCIENCE

MONTHLY.

APRIL, 1892.

AGASSIZ AT PENIKESE.

By Prof. DAVID STARR JORDAN,

PRESIDENT OF THE LELAND STANFORD JUNIOR UNIVERSITY.

AGASSIZ was above all else a teacher. His mission in America was that of a teacher of science—of science in the broadest sense as the orderly arrangement of all human knowledge. He would teach men to know, not simply to remember or to guess. He believed that men in all walks of life would be more useful and more successful through the thorough development of the powers of observation and judgment. He would have the student trained through contact with real things, not merely exercised in the recollection of the book descriptions of things. "If you study Nature in books," he said, "when you go out of doors you can not find her."

Agassiz was once asked to write a text-book in zoölogy for the use of schools and colleges. Of this he said: "I told the publishers that I was not the man to do that sort of thing, and I told them, too, that the less of that sort of thing which is done the better. It is not school-books we want, it is students. The book of Nature is always open, and all that I can do or say shall be to lead young people to study that book, and not to pin their faith to any other."

He taught natural history in Harvard College as no other man had taught in America before. He was "the best friend that ever student had," because the most genial and kindly. Cambridge people used to say that one had "less need of an overcoat in passing Agassiz's house" than any other in that city.

In the interest of popular education as well as of scientific research, Agassiz laid the foundation of the Museum of Comparative Zoölogy. Here, in the face of all sorts of discouragements,

he worked with wonderful zeal, which showed its results in the success of everything with which he had to do.

Of the older teachers of biology in America, the men who were born between 1830 and 1850, nearly all who have reached eminence have been at one time or another pupils of Agassiz. The names of Le Conte, Hartt, Shaler, Scudder, Wilder, Putnam, Packard, Clark, Alexander Agassiz, Morse, Lyman, Brooks, Whitman, Garman, Faxon, Fewkes, Minot, and many others not less worthily known, come to our thoughts at once as evidence of this statement.

Even as late as 1873, when Agassiz died, the Museum of Comparative Zoölogy was almost the only school in America where the eager student of natural history could find the work he wanted. The colleges generally taught only the elements of any of the sciences. Twenty years ago original research was scarcely considered as among the functions of the American college. Such investigators as America had were for the most part outside of the colleges, or at the best carrying on their investigations in time stolen from the drudgery of the class-room. One of the greatest of American astronomers was kept for forty years teaching algebra and geometry, with never a student far enough advanced to realize the real work of his teacher. And this case was typical of hundreds before the university spirit was kindled in American schools. That this spirit was kindled in Harvard forty years ago was due in the greatest measure to Agassiz's influence. It was here that graduate instruction in science in America practically began. In an important sense the Museum of Comparative Zoölogy was the first American university.

Notwithstanding the great usefulness of the museum and the broad influence of its teachers, Agassiz was not fully satisfied. The audience he reached was still too small. Throughout the country the great body of teachers of science went on in the old mechanical way. On these he was able to exert no influence. The boys and girls still kept up the humdrum recitations from worthless text-books. They got their lessons from the book, recited them from memory, and no more came into contact with Nature than they would if no animals or plants or rocks existed on this side of the planet Jupiter.

It was to remedy this state of things that Agassiz conceived, in 1872, the idea of a scientific "camp-meeting," where the workers and the teachers might meet together—a summer school of observation where the teachers should be trained to see Nature for themselves and teach others how to see it.

The first plan suggested was that of calling the teachers of the country together for a summer outing on the island of Nantucket. Before the site was chosen, Mr. John Anderson, a wealthy tobacco

merchant in New York city, offered to Agassiz the use of his island of Penikese, together with a large yacht and an endowment of fifty thousand dollars in money, if he would permanently locate this scientific "camp-meeting" on the island. Thus was founded the Anderson School of Natural History on the island of Penikese.

Penikese is a little island containing about sixty acres of very rocky ground, a pile of stones, with intervals of soil. It is the last and least of the Elizabeth Islands, lying to the south of Buzzard's Bay, on the south coast of Massachusetts. The whole cluster was once a great terminal moraine of rocks and rubbish of all sorts, brought down from the mainland by some ancient glacier, and by it dropped into the ocean off the heel of Cape Cod. The sea has broken up the moraine into eight little islands by wearing tide channels between hill and hill. The names of these islands are recorded in the jingle which the children of that region learn before they go to school:

> "Naushon, Nonamesset, Uncatena, and Wepecket,
> Nashawena, Pesquinese, Cuttyhunk, and Penikese."

And Penikese, last and smallest of them, lies, a little forgotten speck, out in the ocean, eighteen miles south of New Bedford. It contains two hills, joined together by a narrow isthmus, a little harbor, a farm-house, a flag-staff, a barn, a willow tree, and a flock of sheep. And here Agassiz founded his school. This was in the month of June in the year 1873.

From the many hundred applicants who sent in their names as soon as the school was made public Agassiz chose fifty—thirty men, twenty women—teachers, students, and naturalists of various grades from all parts of the country. This practical recognition of coeducation was criticised by many of Agassiz's friends, trained in the monastic schools of New England, but the results soon justified the decision. These fifty teachers should be trained so far as he could train them in right methods of work. They should carry into their schools his own views of scientific teaching. Then each of these schools would become in its time a center of help to others, until the influence toward real work in science should spread throughout our educational system.

None of us will ever forget his first sight of Agassiz. We had come down from New Bedford in a little tug-boat in the early morning, and Agassiz met us at the landing-place on the island. He was standing almost alone on the little wharf, and his great face beamed with pleasure. For this summer school, the thought of his old age, might be the crowning work of his lifetime. Who could foresee what might come from the efforts of fifty men and women, teachers of science, each striving to do his work in the

best possible way? His thoughts and hopes rose to expectations higher than any of us then understood.

His tall, robust figure, broad shoulders bending a little under the weight of years, his large round face lit up by kindly dark-brown eyes, his cheery smile, the enthusiastic tones of his voice, all these entered into our first as well as our last impressions of Agassiz. He greeted us with great warmth as we landed. He looked into our faces to justify himself in making choice of us among the many whom he might have chosen.

The roll of the Anderson School has never been published, and I can only restore a part of it from memory. Among those whose names come to my mind as I write are Dr. Charles O. Whitman, now of Clark University; Dr. William K. Brooks, of Johns Hopkins; Dr. Frank H. Snow, now Chancellor of the University of Kansas; Dr. W. O. Crosby, of the Boston Society of Natural History, then a boy from Colorado interested in rocks and minerals; Samuel Garman, Walter Faxon, Walter Fewkes, and Charles Sedgwick Minot, all of them still connected with the work at Cambridge; Ernest Ingersoll, then just beginning his literary work; Prof. Scott, of the Normal School at Westfield; Prof. Stowell, of the school at Cortland; Prof. Apgar, of Trenton, N. J.; Prof. Fernald, of Maine; Miss Susan Hallowell, of Wellesley College; Miss Mary Beaman (Mrs. Joralemon); Mr. E. A. Gastman, of Illinois; and other well-known instructors. With these was the veteran teacher of botany at Mount Holyoke Seminary, Miss Lydia W. Shattuck, with her pupil and associate, Miss Susan Bowen. Prof. H. H. Straight and his bride, both then teachers in the State Normal School at Oswego, were also with us. These four, whom all of us loved and respected, were the first of our number to be claimed by death.

Among our teachers, besides Agassiz, were Burt G. Wilder, Edward S. Morse, Alfred Mayer, Frederick W. Putnam, then young men of growing fame, with Arnold Guyot and Count Pourtalès, early associates of Agassiz, already in the fullness of years. Mrs. Agassiz was present at every lecture, note-book in hand, and her genial personality did much to bind the company together.

The old barn on the island had been hastily converted into a dining-hall and lecture-room. A new floor had been put in, but the doors and walls remained unchanged, and the swallows' nests were undisturbed under the eaves. The sheep had been turned out, the horse-stalls were changed to a kitchen, and on the floor of the barn, instead of the hay-wagon, were placed three long tables. At the head of one of these sat Agassiz. At his right hand always stood a movable blackboard, for he seldom spoke without a piece of chalk in his hand. He would often give us a

lecture while we sat at the table, frequently about some fish or other creature, the remains of which still lay beside our plates.

Our second day upon the island was memorable above all others. Its striking incident has passed into literature in the poem of Whittier, "The Prayer of Agassiz."

When the morning meal was over, Agassiz arose in his place and spoke, as only he could speak, of his purpose in calling us together. The swallows flew in and out of the building in the soft June air, for they did not know that it was no longer a barn but a temple. Some of them almost grazed his shoulder as he spoke to us of the needs of the people for better education He told us how these needs could be met, and of the results which might come to America from the training and consecration of fifty teachers.

This was to him no ordinary school, still less an idle summer's outing, but a mission work of the greatest importance. He spoke with intense earnestness, and all his words were filled with that deep religious feeling so characteristic of all his thoughts. For to Agassiz each natural object was a thought of God, and trifling with God's truth as expressed in Nature was the basest of sacrilege.

What Agassiz said that morning can never be said again. No reporter took his language, and no one could call back the charm of his manner or the impressiveness of his zeal and faith.

At the end he said, "I would not have any man to pray for me now," and that he and each of us would utter his own prayer in silence. What he meant by this was that no one could pray in his stead. No public prayer could take the place of the prayer which each of us would frame for himself. Whittier says:

> "Even the careless heart was moved,
> And the doubting gave assent
> With a gesture reverent
> To the Master well beloved.
> As thin mists are glorified
> By the light they can not hide,
> All who gazed upon him saw,
> Through its veil of tender awe,
> How his face was still uplit
> By the old sweet look of it;
> Hopeful, trustful, full of cheer
> And the love that casts out fear."

And the summer went on with its succession of joyous mornings, beautiful days, and calm nights, with every charm of sea and sky, the master with us all day long, ever ready to speak words of help and encouragement, ever ready to give us from his own stock of learning. The boundless enthusiasm which sur-

rounded him like an atmosphere, and which sometimes gave the appearance of great achievement to the commonest things, was never lacking.

Essentially Latin in his nature, he was always picturesque in his words and his work. He delighted in the love and approbation of his students and his friends, and the influence of his personality sometimes gave his opinions weight beyond the value of the investigations on which they were based. With no other investigator have the work and the man been so identified as with Agassiz. No other of the great workers has been equally great as a teacher. His greatest work in science was his influence on other men.

In an old note-book of those days I find fragments of some of his talks to teachers at Penikese. From this note-book I take some paragraphs, just as I find them written there:

"Never try to teach what you do not yourself know and know well. If your school board insist on your teaching anything and everything, decline firmly to do it. It is an imposition alike on pupils and teacher to teach that which he does not know. Those teachers who are strong enough should squarely refuse to do such work. This much-needed reform is already beginning in our colleges, and I hope it will continue. It is a relic of mediæval times, this idea of professing everything. When teachers begin to decline work which they can not do well, improvements begin to come in. If one will be a successful teacher, he must firmly refuse work which he can not do successfully.

"It is a false idea to suppose that everybody is competent to learn or to teach everything. Would our great artists have succeeded equally well in Greek or calculus? A smattering of everything is worth little. It is a fallacy to suppose that an encyclopædic knowledge is desirable. The mind is made strong not through much learning, but by the thorough possession of something."

"Lay aside all conceit. Learn to read the book of Nature for yourself. Those who have succeeded best have followed for years some slim thread which has once in a while broadened out and disclosed some treasure worth a life-long search."

"A man can not be professor of zoölogy on one day and of chemistry on the next, and do good work in both. As in a concert all are musicians—one plays one instrument, and one another, but none all in perfection."

"You can not do without one specialty. You must have some base-line to measure the work and attainments of others. For a general view of the subject, study the history of the sciences. Broad knowledge of all Nature has been the possession of no naturalist except Humboldt, and general relations constituted his specialty."

"Select such subjects that your pupils can not walk without seeing them. Train your pupils to be observers, and have them provided with the specimens about which you speak. If you can find nothing better, take a house-fly or a cricket, and let each one hold a specimen and examine it as you talk."

"In 1847 I gave an address at Newton, Mass., before a Teachers' Institute conducted by Horace Mann. My subject was grasshoppers. I passed around a large jar of these insects, and made every teacher take one and hold it while I was speaking. If any one dropped the insect, I stopped till he picked it up. This was at that time a great innovation, and excited much laughter and derision. There can be no true progress in the teaching of natural science until such methods become general."

"There is no part of the country where in the summer you can not get a sufficient supply of the best specimens. Teach your children to bring them in yourselves. Take your text from the brooks, not from the booksellers. It is better to have a few forms well known than to teach a little about many hundred species. Better a dozen specimens thoroughly studied as the result of the first year's work, than to have two thousand dollars' worth of shells and corals bought from a curiosity-shop. The dozen animals would be your own."

"You* will find the same elements of instruction all about you wherever you may be teaching. You can take your classes out and give them the same lessons, and lead them up to the same subjects you are yourselves studying here. And this method of teaching children is so natural, so suggestive, so true. That is the charm of teaching from Nature herself. No one can warp her to suit his own views. She brings us back to absolute truth as often as we wander."

"The study of Nature is an intercourse with the highest mind. You should never trifle with Nature. At the lowest her works are the works of the highest powers, the highest something in whatever way we may look at it."

"A laboratory of natural history is a sanctuary where nothing profane should be tolerated. I feel less agony at improprieties in churches than in a scientific laboratory."

"In Europe I have been accused of taking my scientific ideas from the Church. In America I have been called a heretic because I will not let my church-going friends pat me on the head."

Of all these lectures the most valuable and the most charming were those on the glaciers. In these the master spoke, and every rock on our island was a mute witness to the truth of his words.

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* In this paragraph, quoted by Mrs. Agassiz (Life and Letters of Agassiz, p. 775), I have adopted the wording as given by her.

He often talked to us of the Darwinian theory, to which in all its forms he was most earnestly opposed. Agassiz was essentially an idealist. All his investigations were to him not studies of animals or plants as such, but of the divine plans of which their structures are the expression. "That earthly form was the cover of spirit was to him a truth at once fundamental and self-evident." The work of the student was to search out the thoughts of God, and as well as may be to think them over again. To Agassiz these divine thoughts were especially embodied in the relations of animals to each other. The species was the thought-unit, the individual reproduction of the thought in the divine mind at the moment of the creation of the first one of the series which represents the species. The marvel of the affinity of structure—of unity of plan in creatures widely diverse in habits and outward appearance—was to him a result of the association of ideas in the divine mind, an illustration of divine many-sidedness. To Darwin these same relations would illustrate the force of heredity acting under diverse conditions of environment.

Agassiz had no sympathy with the prejudices worked upon by weak and foolish men in opposition to Darwinism. He believed in the absolute freedom of science; that no power on earth can give answers beforehand to the questions which men of science endeavor to solve. Of this I can give no better evidence than the fact that every one of the men specially trained by him has joined the ranks of the evolutionists. He would teach them to think for themselves, not to think as he did.

The strain of the summer was heavier than we knew. Before the school came to an end, those who were nearest him felt that the effort was to be his last. His physician told him that he must not work, must not think. But all his life he had done nothing else. To stop was impossible, for with his temperament there was the sole choice between activity and death.

And in December the end came. In the words of one of his old students, Theodore Lyman, "We buried him from the chapel that stands among the college elms. The students laid a wreath of laurel on his bier, and their manly voices sang a requiem. For he had been a student all his life long, and when he died he was younger than any of them."

The next summer, the students of the first year came together at Penikese, and many eager new faces were with them. Wise and skillful teachers were present, but Agassiz was not there, and the sense of loss was felt above everything else. The life was gone out from Penikese, and at the end of the summer the authorities of the museum closed the doors of the Anderson School forever. The buildings stand on the island, just as we left them in 1874, a single old sea-captain in charge of them all these years, until last

winter, when he was lost in a storm. The blackboards in the lecture-hall * still bear the inscriptions left on them by the students and taken from the words of the master:

"STUDY NATURE, NOT BOOKS."

"BE NOT AFRAID TO SAY NO.

"A LABORATORY IS A SANCTUARY WHICH NOTHING PROFANE SHOULD ENTER."

But, while the island of Penikese is deserted, the impulse which came from Agassiz's work there still lives, and is felt in every field of American science.

With all appreciation of the rich streams which in late years have come to us from Germany, it is still true that "the school of all schools which has most influence on scientific teaching in America was held in an old barn on an uninhabited island some eighteen miles from the shore. It lasted but three months, and in effect it had but one teacher. The school at Penikese existed in the personal presence of Agassiz; when he died it vanished!"

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XV. ASTRONOMY.

BY ANDREW DICKSON WHITE, LL. D., L. H. D.,
EX-PRESIDENT OF CORNELL UNIVERSITY.

PART II.

WHILE news of triumphant attacks upon him and upon the truth he had established were coming in from all parts of Europe, Galileo prepared a caréful treatise in the form of a dialogue, exhibiting the arguments for and against the Copernican and Ptolemaic systems, and offered to submit to any conditions that the Church tribunals might impose if they would allow it to be printed. At last, after discussions which extended through eight years, they consented, imposing a humiliating condition;—the preface written in accordance with the ideas of Father Ricciardi, Master of the Sacred Palace, and signed by Galileo, in which the Copernican theory was virtually exhibited as a play of the imagination, and not at all as opposed to the Ptolemaic doctrine reasserted in 1616 by the Inquisition under the direction of Pope Paul V.†

* According to Dr. Carl H. Eigenmann, who has lately visited the island.

† As to the general style of the attacks, see Fromundus's book, cited above, *passim*, but especially the heading of chapter vi, and the argument in chapters x and xi. For interesting reference to one of Fromundus's arguments, showing, by a mixture of mathematics and theology, that the earth is the center of the universe, see Quetelet, Histoire des Sciences mathématiques et physiques, Bruxelles, 1864, p. 170; also, Mädler, Geschichte der Astronomie, vol. i, p. 274.

This new work of Galileo—the "Dialogo"—appeared in 1632, and met with prodigious success. It put new weapons into the hands of the supporters of the Copernican theory. The pious preface was laughed at from one end of Europe to the other. This roused the enemy. The Jesuits, Dominicans, and the great majority of the clergy returned to the attack more violent than ever, and in the midst of them stood Pope Urban VIII, most bitter of all. His whole power was now thrown against Galileo. He was touched in two points: first, in his personal vanity, for Galileo had put his arguments into the mouth of one of the persons in the dialogue and their refutation into the mouth of another; but, above all, he was touched in his religious feelings. Again and again he insisted to all comers on the absolute and specific declarations of Holy Scripture, which prove that the sun and heavenly bodies revolve about the earth, and declared that to gainsay them is simply to dispute revelation. Certainly, if one ecclesiastic more than another ever seemed *not* under the care of the Spirit of Truth, it was Urban VIII in all this matter.

Herein was one of the greatest pieces of ill fortune that has ever befallen the older Church. Had Pope Urban been broad-minded and tolerant like Benedict XIV, or had he been taught moderation by adversity like Pius VII, or had he possessed the large scholarly qualities of Leo XIII, now reigning, the vast scandal of the Galileo case would never have burdened the Church: instead of devising endless quibbles and special pleadings to escape responsibility for this colossal blunder, its defenders could have claimed forever for the Church the glory of fearlessly initiating a great epoch in human thought.

But it was not so to be. Urban was not merely Pope, he was also a prince of the house of Barberini, and therefore doubly angry that his arguments had been publicly controverted.

The opening strategy of Galileo's enemies was to forbid the sale of his work; but this was soon seen to be unavailing, for the first edition had already been spread throughout Europe. Urban now became more angry than ever, and both Galileo and his works were placed in the hands of the Inquisition. In vain did the good Benedictine, Castelli, urge that Galileo was entirely respectful to the Church; in vain did he insist that "nothing that can be done can now hinder the earth from revolving." He was dismissed in disgrace, and Galileo was forced to appear in the presence of the dread tribunal without defender or adviser. There, as was so long concealed, but as is now fully revealed, he was menaced with torture again and again by express order of Pope Urban, and, as is also thoroughly established from the trial documents themselves, forced to abjure under threats, and subjected to imprisonment by command of the Pope; the Inquisition defer-

ring in this whole matter to the papal authority. All the long series of attempts made in the supposed interest of the Church to mystify these transactions have at last failed. The world knows now that Galileo was subjected certainly to indignity, to imprisonment, and to threats equivalent to torture, and was at last forced to pronounce publicly and on his knees his recantation, as follows:

"I, Galileo, being in my seventieth year, being a prisoner and on my knees, and before your Eminences, having before my eyes the Holy Gospel, which I touch with my hands, abjure, curse, and detest the error and the heresy of the movement of the earth." *

He was vanquished indeed, for he had been forced, in the face of all coming ages, to perjure himself. To complete his dishonor, he was obliged to swear that he would denounce to the Inquisition any other man of science whom he should discover to be supporting the "heresy of the motion of the earth."

Many have wondered at this abjuration, and on account of it have denied to Galileo the title of martyr. But let such gainsayers consider the circumstances. Here was an old man—one who had reached the allotted threescore years and ten, broken with disappointments, worn out with labors and cares, dragged from Florence to Rome, with the threat from the Pope himself that if he delayed he should be "brought in chains"; sick in body and mind, given over to his oppressors by the grand duke who ought to have protected him, and on his arrival in Rome threatened with torture. What the Inquisition was he knew well. He could remember but as yesterday the burning of Giordano Bruno in that same city for scientific and philosophic heresy; he could remember, too, that only eight years before this very time De Dominis, Archbishop of Spalatro, having been seized by the Inquisition for scientific and other heresies, had died in a dungeon, and that his body and his writings had been publicly burned.

To the end of his life, nay, after his life was ended, the persecution of Galileo was continued. He was kept in exile from his family, from his friends, from his noble employments, and held rigidly to his promise not to speak of his theory. When, in the midst of intense bodily sufferings from disease, and mental sufferings from calamities in his family, he besought some little liberty, he was met with threats of committal to a dungeon. When at

* For various utterances of Pope Urban against the Copernican theory at this period, see extracts from the original documents given by Gebler. For punishment of those who had shown some favor to Galileo, see various citations, and especially those from the Vatican manuscript, Gebler, p. 216. As to the text of the abjuration, see L'Epinois; also Polacco, *Anticopernicus*, etc., Venice, 1644; and for a discussion regarding its publication, see Favaro, Miscellanea Galileana, p. 804.

last a special commission had reported to the ecclesiastical authorities that he had become blind and wasted with disease and sorrow, he was allowed a little more liberty, but that little was hampered by close surveillance. He was forced to bear contemptible attacks on himself and on his works in silence; to see the men who had befriended him severely punished; Father Castelli banished; Ricciardi, the Master of the Sacred Palace, and Ciampoli, the papal secretary, thrown out of their positions by Pope Urban, and the Inquisitor at Florence reprimanded for having given permission to print Galileo's work. He lived to see the truths he had established carefully weeded out from all the Church colleges and universities in Europe, and when in a scientific work he happened to be spoken of as "renowned," the Inquisition ordered the substitution of the word "notorious." *

And now measures were taken to complete the destruction of the Copernican theory, with Galileo's proofs of it. On the 16th of June, 1633, the Holy Congregation, with the permission of the reigning Pope, ordered the sentence upon Galileo, and his recantation, to be sent to all the papal nuncios throughout Europe, as well as to all archbishops, bishops, and inquisitors in Italy; and this document gave orders that the sentence and abjuration be made known "to your vicars, that you and all professors of philosophy and mathematics may have knowledge of it, that they may know why we proceeded against the said Galileo, and recognize the gravity of his error, in order that they may avoid it, and thus not incur the penalties which they would have to suffer in case they fell into the same." †

As a consequence of this, the professors of mathematics and astronomy in various universities of Europe were assembled and these documents were read to them. To the theological authorities this gave great satisfaction; the Rector of the University of Douay, referring to the opinion of Galileo, wrote to the papal nuncio at Brussels, "the professors of our university are so opposed to this fanatical opinion that they have always held that it must be banished from the schools: in our English college at Douay this paradox has never been approved and never will be."

Still another step was taken: the Inquisitors were ordered, especially in Italy, not to permit the publication of a new edition of any of Galileo's works, nor of any similar writings. On the other hand, theologians were urged, now that Copernicus and

* It is not probable that torture in the ordinary sense was administered to Galileo, though it was threatened. See Th. Martin, Vie de Galilée, for a fair summing up of the case. For the substitution of the word "notorious" for "renowned" by order of the Inquisition, see Martin, p. 227.

† For a copy of this document, see Gebler, p. 269. As to the spread of this and similar documents notifying Europe of Galileo's condemnation, see Favaro, pp. 804, 805.

Galileo and Kepler were silenced, to reply to them with tongue and pen. Europe was flooded with these theological refutations of the Copernican system.

To make all complete, there was prefixed to the "Index" of the Church, forbidding "all writings which affirm the motion of the earth," a bull signed by the reigning Pope, which, by virtue of his infallibility as a divinely guided teacher in matters of faith and morals, clinched this condemnation into the consciences of the whole Christian world.

From the mass of books which appeared under the auspices of the Church immediately after the condemnation of Galileo, for the purpose of rooting out every vestige of the hated Copernican theory from the mind of the world, two may be taken as typical. The first of these was a work by Scipio Chiaramonti, dedicated to Cardinal Barberini. Among his arguments against the double motion of the earth may be cited the following:

"Animals, which move, have limbs and muscles; the earth has no limbs or muscles, therefore it does not move. It is angels who make Saturn, Jupiter, the sun, etc., turn round. If the earth revolves, it must also have an angel in the center to set it in motion; but only devils live there; it would therefore be a devil who would impart motion to the earth. . . .

"The planets, the sun, the fixed stars, all belong to one species—namely, that of stars—they therefore all move or all stand still. It seems, therefore, to be a grievous wrong to place the earth, which is a sink of impurity, among the heavenly bodies, which are pure and divine things."

The next, which I select from the mass of similar works, is the *Anticopernicus Catholicus* of Polacco. It was intended to deal a finishing stroke at Galileo's heresy.

In this it is declared: "The Scripture always represents the earth as at rest, and the sun and moon as in motion; or, if these latter bodies are ever represented as at rest, Scripture represents this as the result of a great miracle." . . .

"These writings must be prohibited, because they teach certain principles about the position and motion of the terrestrial globe repugnant to Holy Scripture and to the Catholic interpretation of it, not as hypotheses but as established facts. . . .

"It is possible to work with the hypotheses of Copernicus so as to explain many phenomena. . . . Yet it is not permitted to argue on his premises except to show their falsity."

Speaking of Galileo's book, Polacco says that it "smacked of Copernicanism," and that, "when this was shown to the Inquisition, Galileo was thrown into prison and was compelled to utterly abjure the baseness of this erroneous dogma."

As to the authority of the cardinals in their decree, Polacco

asserts that, since they are the "Pope's Council" and his "brothers," their work is one, except that the Pope is favored with special divine enlightenment.

Having shown that the authority of the Scriptures, of popes, and of cardinals is against the new astronomy, he gives a refutation based on physics. He asks: "If we concede the motion of the earth, why is it that an arrow shot into the air falls back to the same spot, while the earth and all things on it have, in the mean time, moved very rapidly toward the east? Who does not see that great confusion would result from this motion?"

Next he argues from metaphysics, as follows: "The Copernican theory of the earth's motion is against the nature of the earth itself, because the earth is not only cold but contains in itself the principle of cold; but cold is opposed to motion, and even destroys it—as is evident in animals, which become motionless when they become cold."

Finally, he clinches all with a piece of theological reasoning, as follows: "Since it can certainly be gathered from Scripture that the heavens move above the earth, and since a circular motion requires something immovable around which to move, . . . the earth is at the center of the universe."*

But any sketch of the warfare between theology and science in this field would be incomplete without some reference to the treatment of Galileo after his death. He had begged to be buried in his family tomb in Santa Croce; this request was denied. His friends wished to erect a monument over him; this, too, was refused. Pope Urban said to the ambassador Niccolini that "it would be an evil example for the world if such honors were rendered to a man who had been brought before the Roman Inquisition for an opinion so false and erroneous; who had communicated it to many others, and who had given so great a scandal to Christendom." In accordance, therefore, with the wish of the Pope and the orders of the Inquisition, Galileo was buried ignobly, apart from his family, without fitting ceremony, without monument, without epitaph. Not until forty years after did Pierrozzi dare write an inscription to be placed above his bones; not until a hundred years after did Nelli dare transfer his remains to a suitable position in Santa Croce, and erect a monument above them. Even then the old conscientious hostility burst forth: the Inquisition was besought to prevent such honors to "a man condemned for notorious errors"; and that tribunal refused to allow any epitaph to be placed above him which had not been submitted to its

* For Chiaramonti's book and selections given, see Gebler as above, p. 271. For Polacco, see his work as cited, especially Assertiones i, ii, vii, xi, xiii, lxxiii, clxxxvii, and others. The work is in the White Library at Cornell University. The date of it is 1644.

censorship. Nor has that old conscientious consistency in hatred yet fully relented: hardly a generation since has not seen some ecclesiastic like Marini or De Bonald or Rallaye or De Gabriac, suppressing evidence, or torturing expressions, or inventing theories to blacken the memory of Galileo and save the reputation of the Church. Nay, more, there are school histories, widely used, which, in the supposed interest of the Church, misrepresent in the grossest manner all these transactions in which Galileo was concerned. *Sancta simplicitas!* The Church has no worse enemies than those who devise and teach these perversions. They are simply rooting out, in the long run, from the minds of the more thoughtful scholars, respect for the great organization which such writings are supposed to serve. Their work is just as futile as that of writers of school histories which in the supposed Protestant interest misrepresent the Roman doctrine of indulgences.*

The Protestant Church was hardly less energetic against the new astronomy than the mother Church had been. The sacred pre-science of the first Lutheran Reformers was transmitted as a precious legacy, and in the next century was made much of by Calovius. His great learning and determined orthodoxy gave him leadership in the Lutheran Church. Utterly refusing to look at ascertained facts, he cited the turning back of the shadow upon King Hezekiah's dial and the standing still of the sun for Joshua, denied the movement of the earth, and denounced the Copernican view as clearly opposed to Scripture. To this day his arguments are repeated by sundry orthodox leaders of American Lutheranism.

As to the other branch of the reformed Church, Turretin, Calvin's famous successor, even after Kepler and Newton had established the theory of Copernicus and Galileo, put forth his compendium of theology, in which he proved from a multitude of scriptural texts that the heavens, sun, and moon move about the earth, which stands still in the center.† In England we see similar theological efforts even after they had become utterly futile: among the strict churchmen, the great Dr. South denounced the Royal Society as "irreligious," and among the Puritans the eminent John Owen declared that Newton's discoveries were "built on fallible phenomena and advanced by many arbitrary presump-

* For the persecutions of Galileo's memory after his death, see Gebler, Wohlwill, but especially Th. Martin, p. 243, and elsewhere. For the persecution of Galileo's memory, see Th. Martin, chapters ix and x. For documentary proofs, see L'Epinois. For a collection of the slanderous theories invented against Galileo, see Martin, final chapters and appendix. Both these authors are devoted to the Church, but, unlike Monsignor Marini, are too upright to resort to the pious fraud of suppressing documents or interpolating pretended facts.

† For Calovius, see Zoeckler, Geschichte, vol. i, pp. 684 and 763. For Calvin and Turretin, see Shields, The Final Philosophy, pp. 60, 61.

tions against evident testimonies of Scripture." Even Milton seems to have hesitated between the two systems. At the beginning of the eighth book of Paradise Lost he makes Adam state the difficulties of the Ptolemaic system, and then brings forward an angel to make the usual orthodox answers: later, Milton seems to lean toward the Copernican theory, for, referring to the earth, he says:

> "Or she from west her silent course advance
> With inoffensive pace, that spinning sleeps
> On her soft axle, while she faces even
> And bears thee soft with the smooth air along."

Yet English orthodoxy continued to assert itself. In 1724 John Hutchinson, professor at Cambridge, published his *Moses' Principia*, a system of philosophy in which he sought to build up a complete physical system of the universe from the Bible. In this he assaulted the Newtonian theory as "atheistic," and led the way for similar attacks by such Church teachers as Horne, Duncan Forbes, and Jones of Nayland. But one far greater than these involved himself in this view. That same limitation of his reason by the simple statements of Scripture which led John Wesley to declare that "unless witchcraft is true, nothing in the Bible is true," led him, while giving up the Ptolemaic theory and accepting in a general way the Copernican, to suspect the demonstrations of Newton. Happily, his inborn nobility of character lifted him above any bitterness or persecuting spirit, or any imposition of doctrinal tests which could prevent those who came after him from finding their way to the truth.

But in the midst of this vast expanse of theologic error signs of right reason began to appear, both in England and America. Noteworthy is it that Cotton Mather, bitter as was his orthodoxy regarding witchcraft, accepted, in 1721, the modern astronomy fully, with all its consequences.

In the following year came an even more striking evidence that the new scientific ideas were making their way in England. In 1722 Thomas Burnet published the sixth edition of his "Sacred Theory of the Earth." In this he argues as usual to establish the scriptural doctrine of the earth's stability; but in his preface he sounds a remarkable warning. He mentions the great mistake into which St. Augustine led the Church regarding the doctrine of the antipodes, and says, "If within a few years or in the next generation it should prove as certain and demonstrable that the earth is moved, as it is now that there are antipodes, those that have been zealous against it, and engaged the Scripture in the controversy, would have the same reason to repent of their forwardness that St. Augustine would now, if he were still alive."

Fortunately, too, Protestantism had no such power to oppose

the development of the Copernican ideas as the older Church had enjoyed. Yet there were some things in its warfare against science even more indefensible. In 1772 the famous English expedition for scientific discovery sailed from England under Captain Cook. Greatest by far of all the scientific authorities chosen to accompany it was Dr. Priestley. Sir Joseph Banks had especially invited him. But the clergy of Oxford and Cambridge interfered. Priestley was considered unsound in his views of the Trinity; it was evidently suspected that this might vitiate his astronomical observations; he was rejected, and the expedition crippled.

The orthodox view of astronomy lingered on in other branches of the Protestant Church. In Germany even Leibnitz attacked the Newtonian theory of gravitation on theological grounds, though he found some little consolation in thinking that it might be used to support the Lutheran doctrine of consubstantiation.

In Holland the Calvinistic Church was at first strenuous against the whole new system, but we possess a comical proof that Calvinism even in its strongholds was powerless against it. For in 1642 Blaer published at Amsterdam his book on the use of globes, and, in order to be on the safe side, devoted one part of his work to the Ptolemaic and the other to the Copernican scheme, leaving the benevolent reader to take his choice.*

Nor have efforts to renew the battle in the Protestant Church been wanting in these latter days. The attempt in the Church of England in 1864 to fetter science, which was brought to ridicule by Herschel, Bowring, and De Morgan; the assemblage of Lutheran clergy at Berlin in 1868 to protest against "science falsely so called," are examples of these. Fortunately, to the latter came Pastor Knak, and his denunciations of the Copernican theory as absolutely incompatible with a belief in the Bible, dissolved the whole assemblage in ridicule.

In its recent dealings with modern astronomy the wisdom of the Catholic Church in the more civilized countries has prevented its yielding to some astounding errors into which one part of the Protestant Church has tumbled heedlessly.

Though sundry leaders in the older Church have committed

* For the attitude of Leibnitz, Hutchinson, and the others named toward the Newtonian theory, see Lecky, History of England in the Eighteenth Century, chap. ix. For John Wesley, see also his Compendium of Natural Philosophy, being a Survey of the Wisdom of God in the Creation, London, 1784. See also Leslie Stephen, Eighteenth Century, vol. ii, p. 413. For Owen, see his works, vol. xix, p. 310. For Milton, see place cited. For Cotton Mather's view, see The Christian Philosopher, London, 1721, especially pp. 16 and 17. For the case of Priestley, see Weld, History of the Royal Society, vol. ii, p. 56, for the facts and the admirable letter of Priestley upon this rejection. For Humboldt, see his Life, by Bruhns and Lassell, London, 1873, vol. ii, p. 411. Fer Blaer's book, see his L'Usage des Globes, Amsterdam, 1642.

the absurd error of allowing a text-book and sundry review articles to appear which grossly misstate the Galileo episode, with the certainty of ultimately undermining confidence in her teachings among her more thoughtful young men, she has kept clear of the folly of continuing to tie her teachings, and the acceptance of our sacred books, to an adoption of the Ptolemaic theory.

Not so with American Lutheranism. In 1873 was published in St. Louis, at the publishing house of the Lutheran Synod of Missouri, a work entitled *Astronomische Unterredung*, the author being well known to be a late president of a Lutheran Teachers' Seminary.

No attack on the whole modern system of astronomy could be more bitter. On the first page of the introduction the author, after stating the two theories, asks, "Which is right?" and says: "It would be very simple to me which is right, if it were only a question of human import. But the wise and truthful God has expressed Himself on this matter in the Bible. The entire Holy Scripture settles the question that the earth is the principal body (*Hauptkörper*) of the universe, that it stands fixed, and that sun and moon only serve to light it."

The author then goes on to show from Scripture the folly not only of Copernicus and Newton, but of a long line of great astronomers in more recent times. He declares: "Let no one understand me as inquiring first where truth is to be found—in the Bible or with the astronomers. No, I know that beforehand—that my God never lies; never makes a mistake; out of His mouth comes only truth, when He speaks of the structure of the universe, of the earth, sun, moon, and stars. . . .

"Because the truth of the Holy Scripture is involved in this, therefore the above question is of the highest importance to me. . . . Scientists and others lean upon the miserable reed (*Rohrstab*) that God teaches only the order of salvation, but not the order of the universe."

Very noteworthy is the fact that this late survival of an ancient belief based upon text-worship is found not in the teachings of any zealous priest of the mother Church, but in those of an eminent professor in that branch of Protestantism which claims special enlightenment.*

Nor has the warfare against the dead champions of science been carried on by the older Church alone.

* For the amusing details of the attempt in the English Church to repress science, and of the way in which it was met, see De Morgan, Paradoxes, p. 42. For Pastor Knak and his associates, see the Revue des Deux Mondes, 1868. For the recent Lutheran works against the Copernican astronomy, see among others Astronomische Unterredung zwischen einem Liebhaber der Astronomie und mehreren berühmten Astronomer der Neuzeit. J. C. W. L. St. Louis, 1873.

On the 10th of May, 1859, Alexander von Humboldt was buried. His labors had been among the glories of the century, and his funeral was one of the most imposing that Berlin had ever seen: among those who honored themselves by their presence was the prince regent, afterward the Emperor William I; but of the clergy it was observed that none were present save the officiating clergyman and a few regarded as unorthodox.*

We return now to the sequel of the Galileo case.

Having gained their victory over Galileo, living and dead, having used it to scare into submission the professors of astronomy throughout Europe, conscientious churchmen exulted. Loud was their rejoicing that the "heresy," the "infidelity," the "atheism" involved in believing that the earth revolves about its axis and moves around the sun had been crushed by the great tribunal of the Church, acting in strict obedience to the expressed will of one Pope and the written order of another. As we have seen, all books teaching this hated belief were put upon the Index of books forbidden to Christians, and that Index was prefaced by a bull enforcing this condemnation upon the consciences of the faithful throughout the world, and signed by the reigning Pope.

The losses to the world during this complete triumph of theology were even more serious than at first appears: one must especially be mentioned. There was then in Europe one of the greatest thinkers ever given to mankind—René Descartes.† Mistaken though many of his theories were, they bore a rich fruitage of truth. The scientific warriors had stirred new life in him, and he was working over and summing up in his mighty mind all the researches of his time The result would have made an epoch in history. His aim was to combine all knowledge and thought into a Treatise on the World, and in view of this he gave eleven years to the study of anatomy alone. But the fate of Galileo robbed him of all hope, of all courage; the battle seemed lost; he gave up his great plan forever.

But ere long it was seen that the triumph was really a prodigious defeat. From all sides came proofs that Copernicus and Galileo were right; and although Pope Urban and the Inquisition held Galileo in strict seclusion, forbidding him even to *speak* regarding the double motion of the earth; and although this condemnation of "all books which affirm the motion of the earth"

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* See Bruhns and Lassell, Life of Humboldt, London, 1873, vol. ii, p. 411.

† For Descartes's discouragement, see Humboldt, Cosmos, London, 1851, vol. iii, p. 21; also, Lange, Geschichte des Materialismus, vol. i, p. 222, where the letters of Descartes are given, showing his despair, and the relinquishment of his best thoughts and works in order to preserve peace with the Church; also, Saisset, Descartes et ses Précurseurs, pp. 100 *et seq.*; also, Jolly, Histoire du Mouvement intellectuel au XVIe Siècle, vol. i, p. 390.

was kept on the Index; and although the papal bull still bound the "Index" and the condemnations in it on the consciences of the faithful; and although colleges and universities under Church control were compelled to teach the old doctrine;—it was seen by clear-sighted men everywhere that this victory of the Church was a disaster to the victors.

New champions pressed on. Campanella, full of vagaries as he was, wrote his Apology for Galileo, though for that and other heresies, religious and political, he seven times underwent torture.

And Kepler comes: he leads science on to greater victories. Copernicus, great as he was, could not disentangle scientific reasoning entirely from the theological bias. The doctrines of Aristotle and Thomas Aquinas as to the necessary superiority of the circle had vitiated the minor features of his system, and left breaches in it through which the enemy was not slow to enter: but Kepler sees these errors, and by wonderful genius and vigor he gives to the world the three laws which bear his name, and this fortress of science is complete. He thinks and speaks as one inspired. His battle is severe. He is solemnly warned by the Protestant Consistory of Stuttgart "not to throw Christ's kingdom into confusion with his silly fancies," and as solemnly ordered to "bring his theory of the world into harmony with Scripture": he is sometimes abused, sometimes ridiculed, sometimes imprisoned. Protestants in Styria and Würtemberg, Catholics in Austria and Bohemia press upon him; but Newton, Halley, Bradley, and other great astronomers follow, and to science remains the victory.*

Yet this did not end the war. During the seventeenth century, in all France, after all the splendid proofs added by Kepler, no one dared openly teach the Copernican theory, and Cassini, the great astronomer, never declared it. In 1672 the Jesuit, Father Riccioli, declared that there were precisely forty-nine arguments for the Copernican theory and seventy-seven against it. Toward the end of the seventeenth century, after the demonstrations of Sir Isaac Newton, even Bossuet, the great Bishop of

* For Campanella, see Amabile, Fra Tommaso Campanella, Napoli, 1882, especially vol. iii; also, Libri, vol. iv, pp. 149 *et seq.* Fromundus, speaking of Kepler's explanation, says, "Vix teneo ebullientem risum." This is almost equal to the New York Church Journal, speaking of John Stuart Mill as "that small sciolist," and of the preface to Dr. Draper's great work as "chippering." How a journal, generally so fair in its treatment of such subjects, can condescend to such weapons, is one of the wonders of modern journalism. For the persecution of Kepler, see vol. i, p. 392; also Heller, Geschichte der Physik, vol. i, pp. 281 *et seq.*; also Reuschle, Kepler und die Astronomie, Frankfurt a. M., 1871, pp. 87 *et seq.*; also Professor Sigwart, Kleine Schriften pp. 211 *et seq.* There is poetic justice in the fact that these two last-named books come from Würtemberg professors. See also the New Englander for March, 1884, p. 178.

Meaux, the foremost theologian that France has ever produced, declared it contrary to Scripture.

Nor did matters seem to improve rapidly in the following century. In England, John Hutchinson, as we have seen, published in 1724 his *Moses' Principia* maintaining that the Hebrew Scriptures are a perfect system of natural philosophy, and are opposed to the Newtonian system of gravitation; and, as we have also seen, he was followed by a long list of noted men in the Church. In France, two eminent mathematicians published in 1748 an edition of Newton's Principia; but, in order to avert the censure of the Church, they felt obliged to prefix to it a statement absolutely false. Three years later, Boscovich, the great mathematician of the Jesuits, used these words: "As for me, full of respect for the Holy Scriptures and the decree of the Holy Inquisition, I regard the earth as immovable; nevertheless, for simplicity in explanation I will argue as if the earth moves; for it is proved that of the two hypotheses the appearances favor that idea."

In Germany, especially in the Protestant part of it, the war was even more bitter, and it lasted through the first half of the eighteenth century. Eminent Lutheran doctors of divinity flooded the country with treatises to prove that the Copernican theory could not be reconciled with Scripture.

In the theological seminaries and in many of the universities where clerical influence was strong they seemed to sweep all before them; and yet at the middle of the century we find some of the clearest-headed of them aware of the fact that their cause was lost.*

In 1757 the most enlightened perhaps in the whole line of the popes, Benedict XIV, took up the matter, and the Congregation of the Index secretly allowed the ideas of Copernicus to be tolerated. Yet in 1765 Lalande, the great French astronomer, tried in vain at Rome to induce the authorities to remove Galileo's works from the Index. Even at a date far within our own nineteenth century the authorities of many universities in Catholic Europe, and especially those in Spain, excluded the Newtonian system: in 1771 the greatest of them all, the University of Salamanca, being urged to teach physical science, refused, making

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* For Cassini's position, see Henri Martin, Histoire de France, vol. xiii, p. 175. For Riccioli, see Daunou, Études Historiques, vol. ii, p. 439. For Bossuet, see Bertrand, p. 41. For Hutchinson, see Lyell, Principles of Geology, p. 48. For Wesley, see his work, already cited. As to Boscovich, his declaration, mentioned in the text, was in 1746, but in 1785 he seemed to feel his position in view of history, and apologized abjectly: Bertrand, pp. 60, 61. See also Whewell's notice of Le Sueur and Jacquier's introduction to their edition of Newton's Principia. For the struggle in Germany, see Zoeckler, Geschichte der Beziehungen zwischen Theologie und Naturwissenschaft, vol. ii, pp. 45 *et seq.*

answer as follows: "Newton teaches nothing that would make a good logician or metaphysician; and Gassendi and Descartes do not agree so well with revealed truth as Aristotle does."

Vengeance upon the dead also has continued far into our own century. On the 5th of May, 1829, a great multitude assembled at Warsaw to honor the memory of Copernicus and to unveil Thorwaldsen's statue of him.

Copernicus had lived a pious, Christian life; he had been beloved for unostentatious Christian charity; with his religious belief no fault had ever been found; he was a canon of the Church at Frauenberg, and over his grave had been written the most touching of Christian epitaphs. Naturally, then, the people expected a religious service; all was understood to be arranged for it; the procession marched to the church and waited. The hour passed, and no priest appeared; none could be induced to appear. Copernicus, gentle, charitable, pious, one of the noblest gifts of God to religion as well as to science, was evidently still under the ban. Five years after that, his book was still standing on the Index of books prohibited to Christians.

The edition of the Index published in 1819 was as inexorable toward the works of Copernicus and Galileo as its predecessors had been; but in the year 1820 came a crisis. Canon Settele, Professor of Astronomy at Rome, had written an elementary book in which the Copernican system was taken for granted. The Master of the Sacred Palace, Anfossi, as censor of the press, refused to allow the book to be printed unless Settele revised his work and treated the Copernican theory as merely a hypothesis. On this Settele appealed to Pope Pius VII. and the Pope referred the matter to the Congregation of the Holy Office. At last, on the 16th of August, 1820, it was decided that Settele might teach the Copernican system as established, and this decision was approved by the Pope. This aroused considerable discussion, but finally, on the 11th of September, 1822, the cardinals of the Holy Inquisition graciously agreed that "the printing and publication of works treating of the motion of the earth and the stability of the sun, in accordance with the general opinion of modern astronomers, is permitted at Rome." This decree was ratified by Pius VII, but it was not until thirteen years later, in 1835, that the condemnation of works defending the double motion of the earth was left out of the Index.

This was not a moment too soon, for, as if the previous proofs had not been sufficient, each of the motions of the earth was now absolutely demonstrated anew, so as to be recognized by the ordinary observer. The parallax of fixed stars, shown by Bessel as well as other noted astronomers in 1838, clinched forever the doctrine of the revolution of the earth around the sun, and in

1851 the great experiment of Foucault with the pendulum showed to the human eye the earth in motion around its own axis. To make the matter complete, this experiment was publicly made in one of the churches at Rome by the eminent astronomer, Father Secchi, of the Jesuits, in 1852—just two hundred and twenty years after the Jesuits had secured Galileo's condemnation.*

INVOLUNTARY MOVEMENTS.

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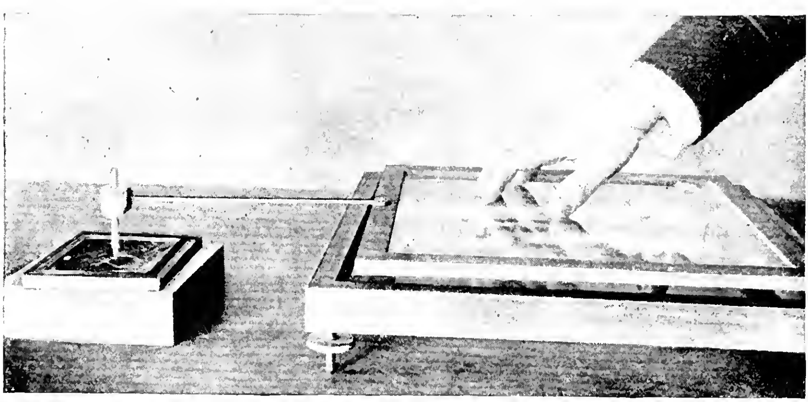
QUITE a number of delusions find a common point of origin in the wide-spread belief that our thoughts and actions are to be completely explained by reference to what our consciousness tells us and what our will directs. The equally important realm of the unconscious and the involuntary is too apt to be overlooked. It is true that we are ready to admit that, in some unusual and semi-morbid conditions, persons will show these untoward phenomena; but we are slow to believe that they have any bearing upon the soundly reasoned and skillfully directed actions of our own intelligence. Accordingly, when from time to time there comes to the front some phenomenon diverging from the ordinary experience of mankind and apparently revealing obscure laws, we fly to some unproved and extreme explanation, and fail to recognize in our daily unconscious and involuntary activity the true source of the apparent mystery. While it is very reasonable to trust the verdict of our consciousness, yet it is equally

* For good statements of the final action of the Church in the matter, see Gebler; also Zoeckler, Geschichte der Beziehungen, etc., ii, 352. See also Bertrand, Fondateurs de l'Astronomie moderne, p. 61; Flammarion, Vie de Copernic, chap. ix. As to the time when the decree of condemnation was repealed, there have been various pious attempts to make it earlier than the reality. Artaud, p. 307, cited in an apologetic article in the Dublin Review, September, 1865, says that Galileo's famous dialogue was published in 1744, at Padua, entire, and with the usual approbations. The same article also declares that in 1818 the ecclesiastical decrees were repealed by Pius VII in full Consistory. Whewell accepts this; but Cantu, an authority favorable to the Church, acknowledges that Copernicus's work remained on the Index as late as 1835 (Cantu, Histoire universelle, vol. xv, p. 483); and with this Th. Martin, not less favorable to the Church, but exceedingly careful as to the facts, agrees; and the most eminent authority of all, Prof. Reusch, of Bonn, in his Index der verbotenen Bücher, Bonn, 1885, vol. ii, p. 396, confirms the above statement in the text exactly as I made it in 1871. For a clear statement of Bradley's exquisite demonstration of the Copernican theory by reasonings upon the rapidity of light, etc., and Foucault's exhibition of the rotation of the earth by the pendulum experiment, see Hoefer, Histoire de l'Astronomie, pp. 492 *et seq.* For more recent proofs of the Copernican theory, by the discoveries of Bunsen, Bischoff, Benzenburg, and others, see Jevons, Principles of Science.

desirable that this confidence should be accompanied by an understanding of the conditions under which the evidence is presumably valid and when likely to mislead. Sense deceptions, faulty observation, exaggeration, neglect, fallacy, illusion, and error abound on all sides and emphasize the need of a calm judgment, a well-equipped intellect, a freedom from haste and prejudice, an appreciation of details and nice distinctions, in the determination of truth and the maintenance of mental health.

For these and other reasons it is important to demonstrate experimentally the readiness with which normal individuals may be made to yield evidence of unconscious and involuntary processes. When, some years ago, the American public was confronted with the striking phenomena of muscle-reading, the wildest speculations were indulged in regarding its true *modus operandi;* and the suggestion that it was due to unconscious indications skillfully interpreted was ridiculed, mainly for the reasons that this explanation was hardly applicable to certain extreme instances involving considerable good fortune, other and subtler modes of interpretation, as well as some exaggeration in the accounts, and that so many worthy and learned persons were absolutely certain that they had given no indications whatever. For a time the view that mind-reading was muscle-reading rested upon rather indirect evidence, and upon modes of reasoning that do not



THE AUTOMATOGRAPH.—When in use a screen is interposed concealing the apparatus from the subject. There is also a sheet of paper on the upper glass plate, which has been removed to show the glass balls.

carry great conviction to the ordinary mind. To supplement this evidence by a clear exposition of the naturalness and regularity of these involuntary movements is our present task.

Inasmuch as the movements in question are often very slight, delicate apparatus is necessary, the description of which may properly precede an account of the results. There is first a strong

wooden frame, holding a heavy plate glass, fifteen inches square, and mounted on three brass legs, with screw adjustments by means of which the plate may be brought into exact level. Upon the plate glass are placed in the form of a triangle three very perfectly turned and polished brass balls, and upon the balls rests a thin crystal plate glass fourteen inches square, set in a light wooden frame. Covering the upper glass is a sheet of paper, and upon the paper the subject lightly rests the finger-tips of one hand. When all is properly adjusted, and glass and balls are rubbed smooth with oil, it is quite impossible to hold the apparatus still for more than a few seconds; the slightest unsteadiness or movement of the hand at once sets the apparatus going. If one closes his eyes and thinks intently of something, one readily forms the conviction that the glass remains quiet, but a bystander is equally convinced of the opposite. The rest of the apparatus is designed to give a permanent record of these movements. Fastened to the light frame containing the upper glass is a slender rod some ten inches long, bearing at its end a cork, and piercing the cork is a small glass tube that serves to hold a snugly fitting glass rod. The rod is drawn to a smooth rounded point, and when in position rests upon a piece of glazed paper that has been blackened over an oil-flame, and is smoothly stretched over a small glass plate. The point of the rod thus records easily and accurately every movement of the hand that is imparted to the upper plate, and by the manner of its adjustment accommodates itself to all irregularities of movement or surface. Inasmuch as the main purpose of the apparatus is to write involuntary movements, it may not be amiss to name it the "automatograph," and speak of the record it yields as an "automatogram." *

FIG. 1.— ⇸ READING COLORS. Time of record, 95 seconds.

In all the figures A represents the beginning of the record, Z the end. In Figs. 4 and 6 the numbers 1, 2, 3, 4 indicate the points of the record 15, 30, 45, 600 seconds—in Fig. 11, 30, 60, 90, 120 seconds—after the start. *The arrow indicates the direction in which the object attended to was situated.* The tracings are permanently fixed by bathing them in a weak solution of shellac and alcohol.

Various means may be employed to hold the attention of the subject in a definite direction, and in all he is instructed to think as little as possible of his hand, making an effort, if he chooses, to

* The apparatus was designed and the results were obtained in the Psychological Laboratory of the University of Wisconsin. The success of the investigation and the labor of obtaining the results are to a great extent due to the skill and industry of Miss Helen West, A. B., 1891, of the University of Wisconsin.

keep it from moving. A large screen is interposed between the subject and the record to prevent him from indirectly seeing what is going on. On the wall facing him, some eight feet distant, are some small patches of color, the names of which he is asked to call out. The colors are small enough to necessitate close attention in their distinction, and the record of the hand, after the subject has been employed in this way for a minute or two, is usually quite significant. An average result is presented in Fig. 1. The hand moves clearly and directly toward the wall where the colors hang; the movement is at times halting and uncertain, but its general trend is unmistakable. Moreover, the result can not in general be anticipated, not alone because there are marked differences between individuals in the readiness with which they will manifest involuntary movements, but also because the intensity of the attention and the momentary condition of the subject are important and variable factors in the result. With very good subjects it becomes quite safe to predict the general nature of the result, and the different tracings of the same subject bear a family resemblance to one another.

Fig. 2.—Reading Colors arranged in Three Rows. Shows movement of the hand parallel with movement of the attention. Time of record, 90 seconds. The first line was read in this direction ↓, the second in this ↑, the third in this ↓. At the turn from the second to the third line the record is interrupted

A more unusual but very striking form of involuntary movement is shown in Fig. 2. As before, the subject's attention was fixed upon the colors on the wall, but these were arranged in three rows, the first being read from left to right, the second from right to left, and the third from left to right again. The record plainly indicates where the change of direction of reading took place; the correspondence between the movements of the hand and of the

attention is perfect, while the movements are unusually direct and extensive. The originator of this record is the best of our subjects, in the sense that the involuntary movements are largest and most predictable.

We may substitute reading from a printed page for the naming of colors and obtain a very similar result. An example is given in Fig. 3, showing, as before, the movement of the hand toward the object of attention.

FIG. 3.— ⇻ READING PRINTED PAGE. Time of record, 45 seconds.

The attention may be directed to a sound as well as to a visual impression; this may be conveniently done by listening to the strokes of a metronome. In order to further strengthen the attention the subject is required to count the strokes, the usual rate being one hundred and forty per minute.

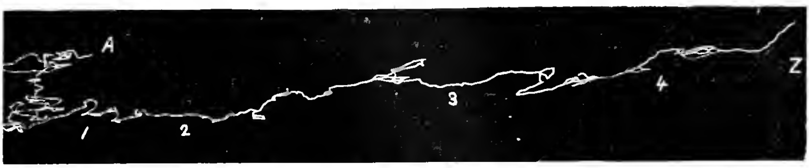


FIG. 4.— ⇻ COUNTING THE STROKES OF A METRONOME. Time of record, 70 seconds. It also illustrates slight hesitation before the movement toward the metronome begins.

The result—a typical illustration is given in Fig. 4—shows that the hand moves toward the metronome. If the metronome be placed in front of the subject in one experiment and behind him in the next, an interesting contrast may be observed. The effect of close attention to the regular strokes of a metronome may show itself in another way. We all appreciate how strong is the tendency to beat time to enlivening music, by tapping with the hands, or stamping with the feet, or nodding with the head; and Dr. Lombard has shown that music is capable of effecting such thoroughly involuntary movements as a sudden rise of the leg when the patella of the knee is struck. It is not surprising, therefore, to find evidences of periodic movements in these automatograms, and in some instances, such

FIG. 5.—COUNTING THE STROKES OF A METRONOME. Shows the oscillation of the movements with the strokes of the metronome.

as Fig. 5, this pervades the whole record. Here the hand moves to and fro, keeping time—not accurately at all, but in a general way—with the strokes of the metronome.

FIG. 6.— → COUNTING THE OSCILLATIONS OF A PENDULUM. Time of record, 45 seconds.

To obtain similar results for a visual impression, a silently swinging pendulum is used, the subject watching the oscillations and counting them. The result is more frequently a movement toward the pendulum, Fig. 6, but occasionally there appear periodic movements due to the pendulum. A very excellent instance of the latter appears in Fig. 7.

FIG. 7.— → COUNTING PENDULUM OSCILLATIONS. Time of record, 80 seconds. Shows movement toward the pendulum at first, and then movements synchronous with its oscillations.

We may more closely approximate the ordinary experiment of the muscle-reader by giving the subject some object to hide, say a knife, and then asking him to place his hand upon the automatograph and think intently of the place of concealment. As before, there is a movement of the hand, and on the basis of the general direction of this movement one may venture a prediction of the direction in which the knife lies. The results will show all grades of success, from complete failure to an accurate localizing of the object, but as good a record as Fig. 8 is not infrequent. In this case the eyes are closed, and we have not the aid of the senses

FIG. 8.— → THINKING OF A HIDDEN OBJECT. Time, 30 seconds.

in maintaining a concentrated attention; moreover, the position of the subject may not be suited to a ready movement in the direction of the hidden object.

A further interesting mode of concentrating the attention con-

sists in thinking of a building or locality in the neighborhood; a very good record obtained in this way appears in Fig. 9.

The peculiar line of Fig. 10 was obtained in an experiment in which a book was slowly carried about the room, the subject being required to continuously read from the page. It is evident that the hand followed the movement of the attention, not pre-

Fig. 9. — Thinking of a Locality. Time, 120 seconds. Also illustrates initial hesitancy followed by steady movement toward the object of thought.

cisely in a circle, but in an irregular outline, closing in upon itself. The great differences between individuals which the experience of the muscle-reader would lead us to expect are not lacking here. Some movements are direct and extensive, others circuitous and brief. Fig. 11 is a good type of a small movement, though it is quite constantly toward the object of the attention. This may be contrasted with another record in which there is a movement of six and a half inches in forty-five seconds. In some cases the first impulse carries the hand toward the object of thought, and is followed by considerable hesitation and uncertainty. A marked example of this tendency may be seen in Fig. 12. There is, too, an opposite type, in which the initial movements are variable, and the significant movement toward the object of thought comes later, when there is perhaps some fatigue. This tendency appears somewhat in Figs. 4 and 9.*

Fig. 10. — Reading from Printed Page, the page being moved about the subject.

How far these movements are involuntary or unconscious must be largely determined by the subjective experiences of those who execute them. While here, as elsewhere, there is some difference

* A further point of importance for future research is the effect of the position of the subject upon the ease of the movement. A sufficient number of experiments were made to show that such an effect exists, and as a result a position was chosen allowing as nearly as possible of equally easy movements in all directions.

among individuals, the consensus of opinion indicates that the subject exercises no essential control over the results; and as a rule he is considerably surprised when the results are first shown to him. At times he becomes conscious of the loss of equilibrium of the apparatus, but the indication is rarely sufficiently definite to inform him of the direction of the movement. Not infrequently the movement is unconsciously performed, and is accompanied by a strong conviction that the apparatus has been stationary. In several cases an intentional simulation of the movements was produced for comparison with the other records; the difference between the two is considerable. An objective mode of determining the precise nature of the movements is certainly desirable, but the subjective experiences are entitled to weighty consideration.

Fig. 11.— ⇸ Counting Pendulum Oscillations. Time, 120 seconds. Illustrates slow and indirect movement.

No elaborate comment upon the significance of these results is necessary. They merely outline the initial steps in the study of involuntary movements, and leave much to be done to complete our knowledge of the details and variations of this interesting but subtle phenomenon. The results go sufficiently far, perhaps, to indicate how readily one may obtain permanent records of involuntary movements, and how closely related these are to the processes upon which the success of the muscle-reader depends. They bear a striking corroboration of the view that all thought is only more or less successfully repressed action, and that, as an eminent muscle-reader puts it, all willing is either pushing or pulling.

Fig. 12.— ⇸ Counting Strokes of Metronome. Time of record, 90 seconds. Illustrates initial directness of movement followed by hesitancy.

The skin of the giraffe, according to M. H. Bryden, is remarkably thick, reaching in some parts three centimetres. A complete specimen, for mounting, is worth from thirteen to twenty-three dollars. The author asserts that the animal easily escapes detection in its natural condition by the resemblance of its long neck to the trunk of a tree.

SCIENCE AND FINE ART.*

By EMIL DU BOIS-REYMOND.

I.

WHEN we represent to ourselves the mental stature of the extraordinary man in whose honor we meet every year on this day, we are ever anew astonished at the boundless breadth of his view and the almost endless diversity of the subjects in which he was interested. It appears hardly comprehensible that the state paper which adjudged the principality of Neufchâtel to the King of Prussia came from the same pen as the Protogea, the Analysis of the Infinite, and the true measure of force from the same head as the pre-established harmony and the Theodicy. Yet on closer examination a gap is revealed in this picture which at first sight appeared all-inclusive. Aside from the Latin poem in which Leibnitz extravagantly glorifies Brand's discovery of phosphorus, we seek in vain for any relation of our hero to art. That his *Ars combinatoria* had nothing to do with fine art does not need to be said. Only occasionally and rarely do we meet in his writings and letters remarks on art and the beautiful. Once he permits himself to be heard at length on the pleasure we receive from music, the causes of which he seeks in a uniform though invisible order in the movements of the trembling strings "which . . . produces in us . . . a harmonious resonance, by which our vital spirits are also moved."† But the world of feeling was only dimly visible to Leibnitz. He saw the Alps and the Italian art treasures with his eyes, but was, as we now say, soul-blind. The same lack of appreciation of fine art is seen in Voltaire, who was comparable for his various learning with Leibnitz; and we have to come down to a third generation, to Diderot in France, and Winckelmann and Lessing in Germany, to find decisive interest in fine art and appreciation of its position in the culture-life of the people.

The period thus defined was, aside from a few phenomenal examples, one of decline in art, while it was one of the most famous in science. When we regard the historical development of these two lines of human activity, we find no conformity in their courses. During the highest bloom of Grecian plastic art there was hardly any science. At the beginning of the art period which we are accustomed to call the *cinque-cento* stands out the giant figure of

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* Address on Leibnitz Commemoration-day in the Academy of Sciences at Berlin, July 3, 1890.

† Die philosophischen Schriften von G. W. Leibnitz. Published by C. J. Gerhardt. Vol. ii, p. 87. Berlin, 1890.

Leonardo da Vinci, who, in addition to his immortal art-creations, was a physicist of high rank, yet he was as such so far ahead of his time that the example can not be cited as evidence that the rise of science conditions also the rise of art. Michael Angelo died on the same day that Galileo was born. In the common eminence of art and science at the beginning of this century we see only a coincidence. Art has since then continued at best at the same height, while science is still careering on its course of irrepressible victory.

The two lines are in fact so different that it is easily to be seen that science can help art and art science only externally. "Nature," said Goethe, addressing Eckermann, without perceiving how sharply his words might be applied to a side of his own scientific efforts—"Nature knows no pastime; she is always true, always earnest, always severe; she is always right, and faults and mistakes are always man's."* In order adequately to perceive the correctness of this expression, one must be accustomed, when he applies his own hand to work as an experimenter or observer, to look into the inexorable face of Nature, and, we might almost say, to take upon himself the immense responsibility that is involved in the determination of even the most insignificant fact. What happens at this moment, under these circumstances, will also happen, under the same circumstances, for a negatively endless time, and will likewise happen after a positively endless time; this is the pregnant significance of every rightly interpreted experiment. Only the mathematician, whose work is more nearly allied to that of the experimental investigator than we are used to conceive, can oppose eternally inviolable laws to the same feeling of responsibility. Sworn witnesses before the tribunal of reality, they both strive after knowledge of the world as it is, within the limits imposed upon us by the nature of our intellect. For this painful pressure under which he labors, the investigator is compensated by the knowledge that even the least of his achievements is a step forward above the highest stage reached by his greatest predecessors; that it may contain the germ of immensely important theoretical knowledge and practical achievements, as Wollaston's lines in the spectrum contained the germ of spectrum analysis; that such a prize invites not only the genius raised up by Nature, but also the conscientious industry of the moderately gifted; and that science, bestowing upon the human mind the mastery of Nature, is the ruling organ of civilization; that without it there never has been a true civilization; and that without it civilization, together with art and its works, might any day sink again hopelessly, as they did on the extinction of the ancient world.

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* Gespräche mit Goethe, etc. Leipsic, 1836, vol. ii, p. 68 (1829).

The investigator can also be comforted with the knowledge that a thoughtless multitude enjoying the benefits conferred upon it by him, hardly knows to whom it owes them; that while the name of every musical *virtuoso* is in all mouths, and is certain of immortality in the Conversations-Lexicons of the fashionable classes, the name is substantially unknown among us of him who achieved that supreme triumph of inventive genius of making perceptible, through a copper wire stretched over wide regions and over mountain and valley, the sound of a voice as though it was speaking into our ears. "Knowledge is earnest, art is happy," we might paraphrase the poet's expression, without lessening its applicability. Art is the empire of the beautiful; of the creation of that which inspires in us a semi-sensational, semi-spiritual pleasure; and saying this we also say that it is in its widest scope an empire of freedom. In it rule no stiff laws; no strict causality binds the events of the present to those of the past and of the future; no standard unconditionally warrants success. The changing taste of times, peoples, and men assumes to praise and blame, as when the magnificence of Gothic church architecture became the sport of the eighteenth century. Here the definition of genius as the talent for patience goes to the ground; its happy inspiration produces a picture that seizes us and lifts us up with an elementary power which seems to mock the profound interpretation subsequently imposed upon it by art criticism; and the favored hand which perfects it is also a benefactor of care-laden manhood. It unfortunately lies in the nature of things that such force is not developed in every age. Here at one time the highest development is attained in some one direction, in trying to reach which again generation after generation despondently exhausts itself. The finest art theories can neither lift the individual over the limits of his natural ability, nor in the great whole prepare a better destiny for a declining art period. Of what profit is the discussion concerning idealism and realism which has divided the art world for a considerable time? Has it protected us against the hardly tolerable excesses of the latter? Seek for something new; the bold raising of a standard which the untaught multitude blindly follows, will bear the victory, till the antiquated is in some way supplemented by the fresh, or till a personality of commanding altitude unquestionably achieves the mastery.

Still less can pure science help art; and thus, intrinsically alien to one another, without either materially influencing the other, they go each its own way—the one steadily rising, sometimes more rapidly, sometimes more slowly, the other rising and falling in majestic waves. To desire to stamp one of the two, art alone, as the mark of the highest development of the power of the human mind, as not rarely occurs to persons unfamiliar with

science, is undoubtedly a mistake; but the human mind really shines the clearest when the luster of art is joined with the luster of science.

Furthermore, the same takes place here as in practical ethics. The lower the morals of an age or a people have sunk, the more talk there is about virtue. The more the native creative strength subsides and is dried up, the higher rises the flood of æsthetic theories. Hermann Lotze's History of Æsthetics in Germany * affords a wearisome and discouraging picture of this long and fruitless movement. The philosophers of all schools have outbid one another in framing abstract formulas for determining exactly what beauty is. It is unity in diversity, or fitness without purpose, or unconscious rationality, or the absolute in sensual existence, or the enjoyed harmony of the absolute spirit, and more of the same kind. But between these qualities ascribed to all beauty nominally constituting its essentials, and the perception of the beautiful, there is no more connection than there is between the ether and sonorous vibrations and the qualities made known to us by them. It would indeed be a vain undertaking to conceive an expression which shall equally cover the various kinds of beauty; the beauty of the Cosmos in contrast to chaos, of a mountain view, of a symphony, of a poetical work, of Ristori as Medea, of a rose; or in fine art alone, the beauty of the Cologne Cathedral, of the Hermes, of the Sistine Madonna, of a *genre* picture, of a landscape, of a picture of still life, or of a Japanese vine-weaving. We prefer to say that we in this as in many other points meet something in our organism that is inexplicable, something inexpressible, but something none the less certainly felt for all that, without which life would pass away grimly bare.

There is in Schiller's works a discussion concerning the beauty of the human body.† He distinguishes between an architectonic beauty and one that depends upon grace. Twenty years ago on Leibnitz's day, in an address on Leibnitz's ideas in later science, I attacked the rationalism in æsthetics in which the past century had been much entangled, and I ventured among other things the remark that "as little as for the effect of melody is an explanation conceivable of the charm which handsome forms of one sex have for the other." ‡ We can not in fact discern in close consideration, why this form which, according to Fechner, can be represented by a plain equation between three variables, should please us more than a thousand other possibilities. It can not be

* The seventh volume of Die Geschichte der Wissenschaften in Deutschland. Neuere Zeit. Munich, 1888.

† In the essay on Anmuth und Würde.

‡ Reden, etc., vol. i, Leipsic, 1886, pp. 49, 50.

derived from any abstract principle or architectonics or Hogarthian wave-line. A year after my remark, appeared Charles Darwin's Descent of Man, in which the doctrine of sexual selection, which was only indicated in the Origin of Species, was treated in detail and followed out to its consequences. But I have, too, a lively recollection of how Dove, when I was once contending with him against the validity of vitalism, embarrassed me with the objection that profusion prevails in organic nature, as, for example, in the feathers of a peacock, or of a bird-of-paradise, while Maupertuis's law of the least action excludes such waste in inorganic nature. The problem seems to be solved now, under the presumption that a kind of sense of beauty in their species exists among animals. The brightly colored wedding garment of the male bird may have originated in the females giving the preference to the most highly decorated suitor, under which an ever more richly adorned posterity is developed. The male birds-of-paradise may be seen at pairing-time emulously displaying their beauty before the female. The nightingale's gift of song may likewise be accounted for if, instead of pleasure in colored feathers, we ascribe musical perceptions to the females. Darwin carries his idea further, to the extent of assuming that certain sexual marks in the human race, the grave beard of the man and the luxuriant hair of the woman, may have been derived through sexual selection*. It is well known that the introduction of handsome Circassian slaves into the harems of prominent Turks has repeatedly changed the original Mongolian type into a figure of nobler pattern. Rising to a higher level, we can now find in the same idea the answer to the question, Where are the roots of the charm which female beauty exercises on man? According to our views, the woman was not made out of a rib of the first man, an assumption which encounters morphological difficulties, but it was the man himself who in the course of numerous generations made his woman by natural selection of such fashion as would please him, and, inversely, the woman her man. We now call this type beau-

* The Descent of Man and Selection in Relation to Sex. London, 1871, vol. ii, pp. 52, 89, 379, 400, 401. In his book on Darwinism, etc. (second London edition, 1889), Mr. Wallace rejected the explanation of the decorative plumage and the song of the male bird through selection by the female, and proposed other interpretations. But a writer recognized by Mr. Wallace himself as equally a student in this line, Mr. C. B. Poulton, in his work, The Colors of Animals, their Meaning and their Use (International Scientific Series), has sturdily taken up the defense of the Darwinian view against this attack, and exposed the untenability of Wallace's later explanation. Mr. Wallace has not failed to reply to this (Nature, No. 1082, vol. xlii, July 24, 1890); while Mr. R. J. Pocock, resting on Mr. G. W. Peckham's investigations, joins Mr. Poulton (ibid., No. 1086, August 1, 1890, p. 405). This is not the place to enter into the question, especially as my conclusion concerning the doctrine of sexual selection still holds, even if Mr. Wallace should be right on the single points of feather ornament and song.

tiful; but it is only necessary to cast a glance upon a Venus by Rubens or Titian, and to think of the many races of men, to recognize how little even this beauty is absolute.

An instance in which beauty seems to have allowed itself to be dismembered to the best advantage is afforded by the beauty that might be called mechanical. It is the least considered, because a peculiar training of the eye is required for its estimation. It is the beauty which a machine or a physical instrument can possess, of which every part has the right measure, the right form and position for its perfection. The definition, unconscious rationality, fits it well, for in this case the pleasure can with full right be traced back to the fact that we, by sufficient training, can unconsciously perceive how exactly that which was necessary has been done to connect firmness with lightness and as much mobility as is required, in order to obtain the most advantageous transference of force without useless expenditure of material. A driving-belt, it is true, looks neither beautiful nor unbeautiful; but since the strength of a connecting-rod needs to be greatest in the middle of its length, it pleases the educated vision to see it gradually swelling out from the ends to the middle. This kind of beauty is of course of most recent origin; and it should be remarked that it was, so far as I know, first perceived and raised to a principle in the making of our physical instruments in Germany by Georg von Reichenbach in Munich. At a time when instruments of perfect mechanical beauty were turned out of the shops of Munich and Berlin, there came to us from France and England only those on which stiff columns and fantastically ornamented cornices gave disagreeable reminders of the impure forms in the architecture and furniture of the Rococo.

I do not recollect what French mathematician in the last century endeavored to account for the impression of perfect satisfaction to the eye which the view of the cupola of St. Peter's in Rome produced. He measured the curves of the cupola, and found that their form was precisely that which under the given conditions afforded, by the rules of the higher statics, the maximum of stability. Thus, unconsciously, guided by a sure instinct, Michael Angelo solved in his model (the cupola was not built till after his death) a problem which was hardly comprehensible to his consciousness, and which had never, in his time, been mathematically discussed. The equation of beauty, if we may call it that, appears, moreover, in this case, to have had several roots; for there is at least one other form of cupola, of which that of the Val-de-Grâce in Paris occurs to me as a type, which makes quite as restful an impression, though perhaps not so elevating, as that of Michael Angelo's.

Mechanical beauty comes in here in the building art, and the

more frequently at this time because the iron constructions of the later period give more occasion than stone structures for its exhibition. The change of material has, according to Anton Hallmann's expression, produced a changed statics of feeling.* In the Eiffel Tower mechanical beauty is in conflict with plastic want of beauty, and in this reveals itself for the first time to many who would not otherwise have had occasion to perceive its effect. The new Forth Bridge is certainly not without it. Yet there is no question that even in stone buildings, besides many traditions and conventional tastes, the pleasure in definite forms, in the gentle swelling and tapering of Doric pillars upward, their expansion into the echinus and abacus, and in the profile of the architectural members, depends on mechanical beauty, as well as on the absence from the agreeable impression they make of the repulsive, which the senseless ornamentation of vulgar styles inflicts upon the refined taste.

Mechanical beauty plays a part even in the forms of organic nature, to the degree that much that is repulsive to the untutored eye delights the educated eye and fills it with admiration. That it is which the anatomist is pleased to discern in the structure of the bones, particularly of the joints; which on other grounds than its contradiction of the way the ancients painted death, makes a death-dance appear repulsive to him; which Benvenuto Cellini, to his credit, comprehended in a skeleton; and which, if only our understanding was adequate, every organized form would illustrate to us even in the aquarium and under the microscope. Even in the building up of the plant structure, Dr. Schwendener has demonstrated an economical adaptation of parts, characteristic of the organization, of which we can discern something in the sight of a broadly rooted oak pushing its massive head up toward air and light.

Mechanical beauty comes into consideration in the contemplation of animal forms, particularly of beasts of prey. A greyhound and a bull-dog, a thoroughbred race-horse and a brewer's draft-horse, a South Down and a merino sheep, an Algau Mountain steer and a Dutch milch-cow, are all handsome, though some among them, like the bull-dog and the Percheron horse, may appear ugly to a stranger; for in all of them the type of the species is modified for some adaptation.

Although science can not, as we have seen, inspire art in its departing life, nor communicate a new impulse to it, it can still afford it an inestimable service of another kind, by increasing its insight and improving its technical means, teaching it useful rules, and guarding it against errors. We are not thinking here

* Kunstbestrebungen der Gegenwart. Berlin, 1842, p. 71.

of a thing so primitive as the preparation of pigments or of certain knacks in casting; the less so because, as is well known, our colors are in a remarkable way poorer than those of an unscientific primitive time, and an unexcelled thinness of the metal is the mark of a genuine Greek bronze statue. It can hardly be necessary to recollect the long story of the benefits of this kind which scientific knowledge has conferred upon art. Linear perspective was discovered by the artists themselves, by Leonardo and Dürer. The laws of reflection and shadow-construction, which were still unknown to the ancient painters, if we may judge from the Pompeiian Narcissus-pictures, followed. In the representation of the rainbow, which had better be left unpainted, many and serious mistakes have been made, notwithstanding the teachings of optics. Statics furnished the sculptor important instruction concerning what is called ponderation. Aërial perspective owes its development, again, to the painters, particularly to those of northern lands.

The advance of science has added to those ancient helps much of importance, although it is not so fundamental, and many naturalists, among them some of the first rank, have interested themselves in making the new knowledge accessible to artists. The great masters of past centuries were guided by their feelings to the proper selection of colors, as, according to Johannes Müller, women of taste of all times are correct in the choice of their clothing;* and the Oriental carpet-weavers are not behind them. But the significance of such unconscious success could be perceived only after the subjective physiology of the sense of sight had been created by the older Darwin, Goethe, Purkinje, Johannes Müller, and others. These matters have been discussed by our fellow-member, Herr Ernst von Brücke, in his Physiology of Colors for industrial art, and his Fragments from the Theory of the Fine Arts,† with such special skill as only the rare combination of the artistic culture acquired in his father's studio with his own physiological knowledge could make possible. Chevreul pursued similar aims in France. Not less did Prof. von Helmholtz embody his profound knowledge of physiological optics in public lectures in the service of art, which owes to him likewise his fruitful conclusions concerning the nature of musical harmony. He explained among other things the relation in which differences of luster of real objects stand to those which the painter controls, and showed what means he could employ to overcome the difficulties growing out of them.‡ By imitation of the irradiation recognized by him in

* Handbuch der Physiologie des Menschen, etc. Vol. ii, Part II, Coblentz, 1838, p. 375.

† Physiologie der Farben, etc. First edition, Leipsic, 1866; second edition, 1887, Bruchstücke, etc., Leipsic, 1877.

‡ Optisches ueber Malerei. Vorträge und Reden, vol. i, Brunswick, 1884. Concerning

its true meaning—a fault of our vision—the painter is even placed in a position to reproduce the dazzling impression of the solar disk. Of this the Castle Gandolfo of Roqueplan in the Raczynski Gallery, through its boldness, affords an interesting example.

The representation of the stars as stars, in the shape in which the stars of decorations are drawn and from the resemblance to which star-fishes are named, rests likewise upon defects of our vision; for the stars of the sky are only shining points without rays, as indeed a few favored eyes see them. The sacred halo, the phosphorescence of holy heads, which in Correggio's Night extends over the whole Christ-child, and objectively illuminates the scene, has nothing to do with this. The origin of that kind of representation, so far as it is not a free sport of fancy, is possibly traced by Herr Exner to the crown of light which one sees in a dewy field in sunshine around the shadow of his own head.* By another defect of the human eye, astigmatism, the more advanced grades of which, such as short-sightedness, belong to pathology, Herr Richard Liebreich was able to explain certain peculiarities long incomprehensible, which disfigured the later works of the distinguished English landscape-painter, Turner.† It would have been easy for a modern oculist to protect him from this fault by properly fitted glasses. Color-blindness, known of old, but thoroughly studied only in our own age, is another very frequent defect of our vision, to which corresponds, in the ear, an inability to distinguish between the tones. A color-blind painter is perhaps not so inconceivable as a musician without hearing.

It might not be practicable to define the limits beyond which optical science can do no more good to the artist. In order to know the laws of the movements of the eyes, to understand wherein close vision is different from far vision, no painter will have reason to regret applying to himself Johannes Müller's remarks in his early paper on the Comparative Physiology of the Sense of Sight. Yet it must be granted that an artist could paint an eye very well without ever having heard of the Sansonian images, on which depends the soft glance of a mild eye as well as the wild fire of an angry, penetrating eye; just as the landscape-painter would paint the blue sky on his canvas no better if he had learned to take note of the yellow brush in every great circle of the heavenly sphere that passes through the sun, which continued unremarked through thousands of years, but has been familiar to physiologists since Haidinger's discovery.

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irradiation compare the Handbuch der physiologischen Optic, second edition. 5. Lieferung. Hamburg and Leipsic, 1889, pp. 394 *et seq.*

* Physiologisches und pathologisches in den bildenden Künsten. Vienna, 1889, p. 17.

† Proceedings of the Royal Institution, etc., weekly evening meeting, Friday, March 6, 1872.

In the much-debated question of the polychromy of the ancient statues and buildings, on the contrary, and of the propriety of adopting it, one observation of the physicists, as appears to me, has not hitherto been sufficiently considered. It is that all colors become whitish under a very strong illumination, so that, on the immediate view of the solar spectrum in the telescope, nearly every impression of color disappears, except for a light-yellow shimmer at the red end.* As the colors become whitish, their glaring contrast disappears, and they blend more harmoniously into one another. Therefore, under a clear sky, the fiery red petticoat of the Contadina, which is repeated so often in Oswald Achenbach's Campagna pictures, as well as the white horse of Wouverman's war-scenes, make no disagreeable impression on the eye. Under the bright Grecian sky, on the Acropolis, in the Poikile, the more or less glaringly painted façades and pillars still had a pleasant effect; in the gray northern light, and in closed rooms, they are not happily introduced.

Wheatstone has materially enriched the capacity of drawing and painting art from another side, by showing with his stereoscope the different manner in which binocular vision distinguishes nearer objects from monocular vision, and also from the binocular vision of objects so remote that the interval between the eyes vanishes before their distance. The impression of a solid body arises only when each of the eyes receives a different view of the object, and is produced by both views blending into one, the corporeal view. Therefore the painter, expressing dimensions of depth only through shading and air-perspective, has never been able to produce a real corporeal appearance on his canvas. While, then, Wheatstone's pseudoscope shows the human face concave in an unusual way, Helmholtz's telestereoscope exaggerates the distance between the eyes, and, without aërial perspective, resolves the far-off forest or mountain into its various elements. The stereoscope with movable pictures, however, confirms old Dr. Robert Smith's explanation of the fact that the moon and sun appear larger by nearly two tenths of their diameters in the horizon than in the zenith, and reduces the problem to the question why we see the vault of the sky rather flattened like a watch-glass than as a hemisphere.

Of vastly greater importance for art is photography, which originated at nearly the same time with the spectroscope. To fasten Della Porta's charming pictures was indeed a dream of artists as well as of physicists, and after the discovery of chloride of silver the no longer unattainable object came in sight. One

* Helmholtz, Handbuch der physiologischen Optic, A. a O. Fourth Part, 1887, pp. 284, 285.

would need to have witnessed Daguerre's discovery, and Arago's report upon it in the Chamber of Deputies, to realize the enthusiasm with which it filled the world. Daguerre's particular process, of only limited application, was soon cast in the shade by one which in its essentials is still in use. But it deserves, perhaps, to be remembered that when the first still imperfect Talbotype process reached us from England nobody foresaw its immense future, and the substitution for the silver plate of paper impregnated with a salt of silver was received with shaking of heads, and was looked upon as a step backward.

Thus photography started upon its wonderful career of victory. It soon assumed the relation to art that Arago had promised for it. Not only has it lightened the work of the architectural, interior, and landscape painter, and made the *camera lucida* superfluous even for panoramas; it has also furnished many useful hints relative to light and shadow, reflection and half-tone, and especially as to the way to give the most natural appearance of bodily projection to figures on a flat. It might be profitable, for the sake of forming a judgment in both directions, to inquire what part photography has had in the origin of the newer schools of painting, of the mannerism of the impressionists, and of the clear-light and free-light painters. It has taught the landscape painter how to reproduce rocks with geological and vegetation with botanical correctness, and to represent glaciers, which was rarely attempted before, and never successfully. It fixed the image of the clouds, although its pictures of the sky were somewhat defective. Finally, it helped the portrait painter without exciting his envy, for, while it caught up only a single often long-while tense expression, it was not adequate to give an average picture of the man, and the unpleasant, stiff photograph was almost proverbially a bad portrait. It furnished painters, however, in many instances with an invaluable groundwork, although it had to be enlivened by the artistic touch. But the newer form of portrait photography is calculated to attract the attention of the artist in many points. Instantaneous photography catches the expression of the countenance and the attitudes during so short an interval that it makes good what escapes in the average expression, and thus leads to most valuable observations. Duchenne and Darwin* recreated the doctrine of expression in emotion; the former by counterfeiting the various expressions by means of electrical stimulation of the muscles of the face, and the latter by following their phylogenetic development through the series of animals. Both presented the artist with photographic images of such expressions by the side of which

* The Expression of the Emotions in Man and Animals. London, 1872.

the drawings used in the art schools for the same purpose appear antiquated. Since then the English anthropologist, Mr. Francis Galton, has solved by photography a problem which was as much beyond the reach of the artist as the representation of the average expression of a person was of the photographer—namely, of collecting into a typical picture the average physiognomy and shape of the head of a considerable number of persons of the same age, race, like degree of mental development, or similar pathological condition or criminal propensity. This is done by causing faint pictures of faces of the same category to cover one another on the same negative.* Prof. Bowditch, of the Harvard Medical School, has in this way taken average (composite) pictures or the types of American students and girl students, drivers and conductors of horse-cars. In the last cases the superiority of the intellectual expression of the conductor type over that of the driver type is very plain. It would have been something for Lavater and Gall.

Again, pathology comes into the service of fine art. Dr. Charcot has recognized, in the photographically fixed convulsive attitudes and distortions of hysterics, the classical representations of possessed persons.† It is indeed most wonderful to see how Raphael, otherwise dwelling only in the ideal, portrayed in his Transfiguration the figure of the possessed boy so realistically that one can with certainty, from the Magendian position of his eyes, diagnosticate a central disease. It is in harmony with this, as was recently remarked in New York, that his left hand is afflicted with an athetoid cramp.‡

[*To be concluded.*]

Experiments by Herr Regel with reference to the influence of external factors on the odor of plants show that the most important is the indirect influence of light on the formation of etheric oils and their evaporation. Heat and light intensify the fragrance of strongly fragrant flowers, which in darkness is lessened without quite disappearing. When the whole plant was darkened, those buds only which were before fairly well developed yielded fragrant flowers, the others were scentless. If, however, only the flowers were darkened, all were fragrant. Other plants open their flowers and are fragrant only by night. When these plants were kept continuously in the dark, they lost their scent, as they lost their starch. When brought into light again, both starch and fragrance returned. Besides light, respiration has a decided influence on the fragrance. In general, the opening of flowers coincides with their fragrance, but there is no necessary connection between these phenomena.

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* Inquiries into Human Faculty and its Development, with Illustrations. London, 1883.

† Compare Exner, a. a. O. S. 21 *et seq.*

‡ Sachs and Peterson, A Study of Cerebral Palsies, etc. Journal of Nervous and Mental Disease, May, 1890.

BACTERIA IN OUR DAIRY PRODUCTS.

By Prof. H. W. CONN.

THERE have been no discoveries in the last half-century more startling than those which are now accumulating upon the subject of bacteriology. Every one knows to-day that bacteria have a causal connection with certain diseases, and the whole civilized world has been recently agitated over the attempts that are being made to combat their effect in the human system. The study of the relation of these organisms to the animal body seems to be producing a revolution in the study of medicine, or rather perhaps is creating a science of medicine, for medicine of the past can hardly be called a science.

We have heard so much of the disease-germs and their evil effects that bacteria are usually looked upon as unmitigated nuisances. It is a doubtful chance if any knowledge of their beneficial effects has passed beyond the reach of the scientist's laboratory and lecture-room. But science has for a long time known that even the bacteria which are not connected with disease are of immense significance in the processes of Nature. The non-pathogenic germs were studied long before the pathogenic forms; but the great attraction offered by the study of disease has led the larger number of bacteriologists in this direction. To-day, however, we are beginning to recognize more than ever the great part played by the harmless bacteria, and to find out that their value in the world far outweighs the injury produced by their mischievous relatives. There is hardly a process in Nature which is not in some way connected with bacteria growth. Fermentation, the raising of bread, the formation of vinegar, the germination of seedlings, the growth of plants, the ripening of fertilizers, the decomposition of animal and vegetable bodies by means of which they are again incorporated into the soil, are all to a greater or less extent dependent on the growth of micro-organisms, either bacteria or yeasts. Without the agency of these organisms to prepare the soil, plants could not grow, and life would soon disappear.

There is no one who is not directly or indirectly connected with the dairy industry. The discoveries of the last twenty years, and more especially those of the last five years, have shown that dairy products are in a large measure connected with the growth of microscopic organisms—some dairy processes, indeed, being nothing more than gigantic breeding experiments. Each of the three chief products of the dairy—milk, butter, and cheese—has its own definite relations to bacteria growth and each must be considered separately.

Milk.—The souring of milk is such a universal phenomenon

that it has until recently been considered a normal character of milk. The last twenty years have, however, demonstrated for us that it is universally caused by bacteria growth. The souring of milk is simply the formation in it of a certain amount of lactic acid, and the acid precipitates the casein of milk just as any other acid would do, and thus forms the curd. But it is bacteria which produce the lactic acid. The presence of micro-organisms in milk was first noticed fifty years ago by Fuchs, but it was not till twenty years later that Pasteur succeeded in showing that these organisms could really produce lactic acid and thus might be the cause of the souring of milk. Fifteen years more were required to show that they were the sole cause of the souring of milk, and to demonstrate the further important point that milk when drawn from the healthy cow contains no bacteria and has therefore no tendency to sour or undergo other unpleasant changes. Since this was first shown by Lister, in 1873, numerous observers have so successfully verified the conclusions of Pasteur and Lister that no possibility of doubt longer remains, and we now know that under normal conditions the milk while in the mammary gland of the healthy cow is free from bacteria, and we have abundant proof that such milk will never sour nor ferment if kept free from bacteria contamination.

Absolutely pure milk is, then, free from bacteria; but when we examine milk that has been standing for a few hours the number of bacteria found in it is almost incredible. By the time that it is five or six hours old milk will contain millions for each tumblerful, and by the time it has reached the city consumer it will frequently contain fifty millions to the quart. Now, if the milk while in the cow contains no bacteria, it follows that this numerous crop must have been planted in the milk during the milking or subsequently. At first thought it seems hardly possible to believe that this immense number of bacteria could have found their way into the milk since the milking. But when we learn that they are abundant in the air; that they are crowded in every particle of dust clinging to the hairs of the cow; that they are always present in the milk-duct for a short distance from its opening, living there in the remains of the milk left from the last milking; that the milk-pail in which the milk is drawn can not be washed clear of them by any ordinary methods; that the milk-cans will always contain them in cracks and chinks even after the most thorough cleansing; that they are always on the hands of the milker; and when, in addition to all this, we learn that bacteria multiply so fast that by actual experiment a single individual may in the course of six hours give rise to three thousand progeny—it no longer remains a marvel that their number is so great in milk of a few hours' standing.

Fortunately, this immense number of bacteria in milk need not especially alarm us, for they are not disease-germs and are harmless to the healthy person. Nevertheless, they are undoubtedly a nuisance in the milk. They can not grow there without producing some effect upon it. Commonly the first change noticeable is the appearance of the well-known odor and taste of sour milk, followed shortly by its curdling. This souring is undoubtedly the result of bacteria growth, and it was at first supposed that there was a single definite species which alone had this power of producing lactic acid. So thought Pasteur and Lister at first, and such a species they described. The species of bacterium studied by them certainly had this power, and it was named *Bacterium lactis* by Lister. In later years the name *Bacillus acidi lactici* has been given to it. By the work of the last six years we have learned that more than one species has the power of souring milk by the formation of lactic acid. Lactic-acid formation is the characteristic of a class of bacteria comprising many species, and even in the ordinary souring of milk under normal conditions it is not always the same species of bacteria which produces the mischief.

While it is true that any one of a number of species of bacteria may produce lactic acid by their growth in milk and thus cause its souring, in other respects these different species do not have the same effect. The formation of lactic acid is not the only change that occurs in the souring of milk. Sour milk has a well-known odor, but this is not due to the lactic acid, since lactic acid is odorless. The formation of such an odor tells us, therefore, that there are other changes going on in the souring of milk. The fact is, that a decomposition of the albuminoids and other substances in the milk is going on, and it is these decomposition products that give the odor. Now, the different species of bacteria do not all produce the same sort of decomposition products. All who are familiar with milk will recall that the character of sour milk is by no means uniform. It differs in the hardness of the curd, in the amount of the whey, in odor, and even in taste. When different specimens of milk are examined just before or just after souring, it is found that the species of bacteria are by no means the same in the different specimens. Each will contain some of the acid-forming class, but the particular species which happen to be present in the different specimens will vary with the different conditions. Different localities and different methods of handling the milk will affect the variety of bacteria that it contains. It will sour in all cases, since all have some of the members of the acid-forming class; but the other accompanying phenomena may be different. Thus we have learned to attribute all the differences in the different specimens of sour milk to the fact that the souring

has been produced under the influence of different species of bacteria. The souring of milk is therefore not a simple or a uniform phenomenon. While it is always the effect of bacteria growth, we recognize many varieties of souring corresponding to the variety of bacteria most abundant in the milk before souring. All this makes little difference to the consumer; in any case the milk is ruined for his purposes, and he is more concerned in preventing such troubles completely than in learning their variety. A remedy seems simple enough. When we have once learned that the whole trouble is caused by bacteria, we see that it is only necessary to keep these organisms out in order to preserve the milk pure and sweet.

From the standpoint of public health also the desirability of freeing milk from these organisms is becoming every day more apparent. It is true that the vast majority of the bacteria in milk are perfectly harmless to the healthy person, even when swallowed in such numbers as above indicated. But, at the same time, it not infrequently happens that disease-germs get into the milk and, finding there a suitable medium for growth, multiply rapidly. They are then served out to all the patrons supplied with the milk. Typhoid fever is certainly disseminated by means of the milk-supply, and there is a growing conviction that the fatal tuberculosis owes much of its prevalence to milk from diseased cows. Other epidemics have also been traced to the same source.

Even if no definite disease-germ chances to be present in the milk, the vast number of harmless forms may render the milk dangerous to all having weak or sensitive digestive organs; for they produce considerable lactic acid, and every one knows that acid is injurious in the food of infants and invalids. The presence of lactic acid is probably a less serious matter than the presence of certain decomposition products which are formed by the same bacteria. These are directly poisonous, and, although they are present in such small quantities that they have no effect on the healthy person, they may be injurious to one whose digestive organs are in a sensitive condition. For a long time doctors have recognized that boiled milk is a safer food for invalids than raw milk, supposing, however, the explanation to be that the cooking renders it more easily digested, just as it does other foods. Recent experiments have shown us that this is not true. On the contrary, boiled milk is less easily digested and absorbed by the system than raw milk. The real reason for the greater safety in drinking boiled milk lies in the fact that it is thus deprived of the disturbing action of the millions of bacteria ordinarily present.

To keep bacteria out of milk is a practical impossibility. Their presence in such quantities in all places renders their access

to it a certainty, and it has only been by exercising the most extraordinary precautions that scientists have in a few cases succeeded in obtaining milk directly from the cow in such a way as to avoid its becoming contaminated during the milking. At the same time much may be accomplished by cleanliness in the barn and the dairy. The presence of disease-germs in the milk is always to be traced to filth or to carelessness in handling the milk, or to diseased cows. Typhoid-fever germs, for instance, can only get into the milk from some unusual source, and tuberculosis germs only from diseased cows. If it were possible to enforce cleanliness in the barns and dairies, and to obtain sufficient care in the handling of milk, we should have no more epidemics spread through the milk-supply. But, in the present state of public ignorance and carelessness as to health, such an enforcement is an impossibility. In our cities and large towns, therefore, the milk-supply must be looked upon as one of the fertile sources for the spread of disease, and it behooves every one to look carefully to the condition of the milk he drinks during times of epidemics, especially of those affecting the digestive organs.

But even with the most extreme care it is impossible for our milkmen to avoid the presence of the more common forms of micro-organisms which will sour the milk. Recognizing, then, that bacteria are sure to get into the milk, we may next ask if there is no way of destroying them after they get in. If we can kill these bacteria, we can of course preserve the milk longer and render it more healthful. It is easy enough to kill the bacteria though every method is open to certain objections. Various chemicals have been suggested for poisoning the bacteria, or at least for delaying their growth, but they are one and all to be condemned, as likely to do more harm than good.

A safer and more effective method for preserving milk is by the use of heat. All bacteria may be killed by heat, and then, if the milk be kept in tightly closed bottles, it will keep sweet indefinitely. For this purpose many sterilizing machines have been invented in the last few years, all based upon the same principle, but differing much in detail. In all cases the milk is subjected to a high heat. Most of them simply heat the milk to a boiling temperature by means of steam or boiling water, but a few, by boiling under pressure, contrive to raise the temperature considerably above boiling water. Although many forms of apparatus have been devised for simplifying the matter, no apparatus is really needed for sterilization. All that is necessary is to put the milk into bottles and boil it for ten minutes with the mouth of the bottle open, then close the mouth and steam it for ten minutes more. This method of sterilization will not kill all of the bacteria in the milk, but it will kill all the disease-germs which are likely

to be in it, and it will so decrease the numbers of the other bacteria that the milk will keep sweet for a long time.

All methods of sterilization that are in use in this country have the disadvantage of giving to the milk the taste which is peculiar to boiled milk, and also of rendering it less easily absorbed by the body. In France and Germany a method has been adopted which accomplishes the purpose without injuring the taste of the milk. Machines are in use in Paris and some other cities which will heat great quantities of milk to a temperature of about 155° Fahr. for a few minutes, and then cool it rapidly to a low temperature. The method has been called the pasteurization of milk. It does not kill all the bacteria, but it does destroy so many of them that it greatly increases the keeping properties of the milk. Moreover, it almost entirely destroys the danger from disease-germs in milk, since nearly all forms likely to occur in milk are killed by this temperature. The advantage of this method is that the temperature of 155° Fahr. does not give to the milk the taste of boiled milk, which most people find unpleasant, and does not render the milk difficult of digestion. These pasteurizing machines have not yet been introduced into this country, and the opportunity exists for some one to develop a thriving business by furnishing pasteurized milk in our large cities. A little experience with its superior keeping properties, and a little knowledge of its greater wholesomeness, would soon create a demand for it in America as it has already done in the larger cities of France and Germany.

Butter.—If bacteria are the enemies of the milkman, they are the allies of the butter and cheese maker. The last few years have shown us that butter owes at least its flavor to bacteria growth in the cream. Butter is made by allowing the cream to separate from the milk by means of its less specific gravity, and then by shaking the cream vigorously until the butter collects in lumps. Now, it has been for a long time recognized that it is a difficult matter to churn sweet cream. It may be shaken for a long time without the separation of the butter, and a smaller amount of butter can be obtained from it than from cream that has been allowed to sour or "ripen" for a time before churning. This, at all events, is true of cream which is separated from the milk by the ordinary method of setting, though it seems less true of cream separated by means of a centrifugal machine. It has also been generally recognized that the butter made from sweet cream lacks the delicate flavor or aroma which is such an important factor in a first-class butter. Sweet-cream butter has a flat, creamy taste, which is not generally desired.

For these reasons butter-makers have learned not to churn cream when fresh, but to allow it to stand awhile and sour, or

"ripen." The cream in a creamery is placed in large vats, and then kept at a constant warm temperature for about twenty-four hours. The cream is stirred frequently during this time, and at the end of the ripening it is seen to have changed its character. It is somewhat acid in taste, is slightly thickened, and has a pleasantly sour odor, though one quite different from that of sour milk. The cream is now churned, and the butter is found to separate readily, the quantity is at its maximum, and the butter obtained has the proper butter aroma.

Bacteriological study of the last few years has shown that this "ripening" is nothing more than a breeding of bacteria on a large scale. There were many bacteria in the cream at the beginning, and the ripening has been conducted at just the temperature at which bacteria grow rapidly. The result is, that their multiplication is marvelously rapid, and the number of bacteria present in ripened cream is beyond comprehension and almost beyond calculation. Five millions in a drop would not be too high an estimate for some specimens.

Now, what are the bacteria doing in the cream during their twenty-four hours' growth? They can not multiply so rapidly without producing profound changes in the cream. So far as the butter-maker is concerned their action is twofold: 1. There is produced in the cream a considerable amount of lactic acid, together with small quantities of other acids. 2. Various decomposition processes are going on which fill the cream with decomposition products, and these give rise to the odor and taste of ripened cream.

To understand the effect that this ripening has upon the butter-making, we must first ask what happens to the cream during the churning. If we look at a drop of milk under the microscope, we find that the butter-fat is in the form of the most minute drops. So small are they that they can not be readily separated from the liquid part of the milk. In cream we simply have the great mass of these drops together, but still not at all fused, like a lot of snow-balls floating in water. In the churn, however, the cream is agitated until the drops are shaken together and made to fuse with each other. They now form masses of fat large enough to be removed from the liquid in which they float, and these masses form the butter. But, looking at the cream more closely, we find a mechanical difficulty in the way of their ready fusion. The fat-drops are not free to move at will, for they are bound together in groups by a sort of slimy substance. As we watch the cream with our microscope we see the fat-globules are not easily shaken together, for the slimy matter prevents their direct contact. This slimy substance must be broken down and the drops shaken into each other before the butter can form into

the large masses necessary for their separation from the liquid. It requires a deal of shaking to accomplish it when the slime is intact, and sweet cream may sometimes be churned for hours without producing the butter. But the ripening prepares the way for the churning. The acid formed by the bacteria gradually dissolves this slime, which is of an albuminous nature, and after it is thus dissolved the difficulty of the fusion is gone and a short shaking in the churn finishes the process. It is plain, too, that a larger amount of butter will be obtained from the cream, for in churning sweet cream much of the fat will be left behind in the form of small drops not to be separated from the slime even after the most vigorous churning.

As mentioned above, the second advantage derived from ripening is the development of the aroma of a first-class butter. Sweet-cream butter is tasteless, and the cause of the butter aroma is to be found in the decomposition products of bacteria growth. While growing in the cream they are splitting up the sugars and albuminoids present and producing decomposition products. Among them are many volatile products which have a prominent odor and taste, and these, as we have seen, produce the odor and taste of ripened cream. Now, of course, the butter obtained from such cream will be affected by these compounds, and thus we see that the delicate aroma of first-class butter is produced by the decomposition products of bacteria growth in the cream. These are volatile, and eventually pass away from the butter in large measure. It is well known that the delicate butter aroma is found only in fresh butter. Old butter is strong enough in its taste, but the peculiar delicate aroma is gone. When first made, however, these volatile substances permeate the butter and explain its flavor. Of course, it is highly essential that only the proper decomposition products should be developed, and for this reason it is a matter of high importance that the ripening shall be stopped at just the right time. If it is not continued long enough, the proper decomposition will not take place; and, on the other hand, if it is continued too long, the volatile products will approach those of putrefaction and give a strong-tasting butter. At just the right moment they are present in sufficient amount to give the butter a pleasant flavor without being so abundant as to give a disagreeable one. The experience of the butter-maker guides him in determining when to stop the bacteria growth, and here is one of the points of skill in butter-making. When the cream is ripe enough he churns it, and this ends the process, so far as the bacteria are concerned, for they cease to grow when the butter is made.

But why should they cease to grow? Why do they not continue to cause the decomposition in the butter? What becomes

of them after the churning? The answer to these questions is simple. Many of the bacteria go off in the buttermilk; many more are removed by the water used in washing, but many of them still remain in the butter. Here, however, their active life is nearly over, for the salt added to the butter checks their growth and their numbers begin to diminish. Butter is not a good medium for their development, and, after a few weeks, they practically disappear. Their growth in the butter is thus so slight that it is of no importance and ordinarily produces no noticeable result. To be sure, the butter may subsequently become rancid, and until recently it has been supposed that the rancidity of butter was due to bacteria growth. Some species of bacteria certainly produce butyric acid, and this is one of the most prominent characteristics of rancid butter. But it has been recently shown that butter may become rancid independently of bacteria growth, the direct oxidizing power of the air producing the effect. Bacteria, it is true, may hasten the process, but they are probably not a necessary cause. After the butter is made, then, the bacteria are of no further importance, and unless there should chance to be some disease-germs among them nothing further will result from their action.

The butter-maker thus forces the bacteria to give to his butter a flavor for which he gets a good price in the market. Unfortunately for him, however, there is more than one species of bacteria which may readily get into his cream and produce its ripening, and not all of them are equally serviceable to him. Many species of bacteria give a very unpleasant flavor to the butter if they are abundant in the ripening cream. While they cut the slime that holds the fat-globules and thus make the churning easy, the aroma produced by different species is by no means always satisfactory. It has been found that many of the species which commonly grow in ripening cream will produce very disagreeable butter if they are allowed to act alone. Others acting alone produce good butter, and the latter must, of course, outweigh the former, or the butter will be unsatisfactory.

The fact is, that during the ripening of the cream a great battle is going on among the different species of bacteria. Some of them find the conditions of the ripening cream favorable to their growth, while others find it less favorable. The favored species multiply rapidly, and may largely crowd out of existence those less favored. Some species may chance to get the start of others by being in greater numbers at the outset, while another species will make up for all drawbacks by having a more rapid rate of multiplication. The final result of the struggle will depend upon an infinite variety of conditions, which will be entirely beyond our knowledge. The condition of the cow, the manner of

milking, the manner of setting the cream, the temperature, etc., will all be important factors favoring one form of bacteria and hindering others. If the battle results in favor of the beneficial species, a good-flavored butter will result, while, if the injurious species should get the upper hand, the butter will be bad. The results are at present beyond the control of the butter-maker. By practice he has found the methods which will commonly result in a good product; but even with his greatest precautions he is occasionally unable to obtain the best butter. At certain seasons of the year failure to obtain good butter is about as common as success even in our best creameries.

Now, bacteriologists would not pretend that the bacteria content of the ripening cream is the sole reason of the variations in the quality of the butter product. Different conditions of the cattle, different food, etc., will all affect the butter, but beyond doubt bacteria have an important part to play. Now, uniformity in the product of the dairy is the great desideratum of the butter-maker. Usually he can make good butter, but sometimes he fails from unexplained causes. The complexity of the ripening process makes it impossible for him to be sure of uniformity in this respect, even though other conditions are constant. But what is to prevent the bacteriologist finding the right bacteria to produce a proper aroma to the butter and furnishing them in quantity to the butter-maker to use in time of trouble? They may then be planted in the cream, and thus a ripening always assured which shall be of the best character. It seems to be entirely possible thus to produce uniformity in this direction. Already in Germany and Denmark and in this country experiments have been started looking in this direction with much promise of success. It is not unlikely, therefore, that before long the butter-maker will have at his command a method of assuring success in the aroma of his butter if he only exercises ordinary skill in the process of its manufacture. If such an artificial ferment may be obtained, uniformity in the ripening of cream will be easy. Perhaps the result will be to bring the different creameries into greater likeness to each other, enabling those which now are unable to obtain a first-class product to improve its flavor by using the right species of bacteria for ripening in the place of the inferior species which are afforded by some localities. This would perhaps not improve the best qualities of butter, but would bring the inferior qualities to a higher standard.

Cheese.—If bacteria are an aid to the butter-maker, they are absolutely indispensable to the cheese manufacturer. Some people do enjoy the taste of sweet-cream butter, and there has been for some time an evident tendency toward a desire for less strongly tasting butter. But no one desires to eat fresh cheese. When

first made, cheese is soft and tastes somewhat like milk curd. It has none of the palatable taste which we find in the cheese of our table. It is a long ripening which gives this taste to the cheese.

Here, again, the ripening process is one of bacteria growth. The millions of bacteria that were in the milk are stored away in the cheese, and instead of being killed here, as they are in the butter, they begin to multiply immediately. Here, too, there is a battle of bacteria, and now one species is in the ascendency and now another. If the wrong species gets the upper hand, the cheese becomes bad, and cheese-makers have their greatest trouble from this source. The bacteria do not grow so rapidly as they do in cream, for the conditions are less favorable, but the ripening is kept up for months, and during the whole time the bacteria are growing. Under their action the character of the cheese slowly changes. Here, again, the decomposition products are responsible for the taste and odor. In some cases, such as Limburger cheese, the action is allowed to continue to the verge of putrefaction. Ordinarily it is not continued so far, but in all cases the cheese-maker favors the growth of certain forms of bacteria by regulating the temperature at which the ripening is carried on. As the ripening continues, certain parts of the cheese are digested and decomposed by the bacteria growth, and, as the products of decomposition accumulate, the taste grows stronger. After a time it is considered fit for the market, but the longer the ripening continues the stronger the taste becomes.

Little is known yet as to the bacteriology of different kinds of cheeses. Whether the different tastes of Edam, Limburger, and other characteristic cheeses is largely due to the character of the bacteria ripening them can not yet be said. Cheese-makers do, however, have much trouble with various irregular forms of ripening, and a great drawback in this business is the lack of uniformity in this respect. Beyond doubt this is due largely, perhaps chiefly, to the variety and number of bacteria which succeed in gaining a foothold in the cheese and contribute to its ripening.

Along the line of cheese manufacture our bacteriologists are promising us help from their researches. Of course, the cheese-maker has never paid any attention to the sort of bacteria which he plants in his cheeses, for he has never heard of them. Sometimes he has unwittingly planted species which produce violent poisons, as is shown by the many instances of death from eating poisonous cheese. Now, our bacteriologists are suggesting that the ripening of cheese may be easily controlled. Artificial cultures of the proper sort may be furnished the cheese-maker, and if these are planted in the cheese not only will the danger from poisonous cheese be prevented, but at the same time the desired taste of the cheese be assured. More than this, when we recognize

the great variety of decomposition products which the different species of bacteria produce, we can see ahead a great development in the varieties of cheese. Who can tell what may be the numerous varieties of cheeses produced when our cheese-makers have learned to ripen their product with pure cultures of different species of bacteria, instead of depending as they do now upon "wild" species which get into the cheese by accident from the milk!

THE GREAT EARTHQUAKE OF PORT ROYAL.

By Colonel A. B. ELLIS.

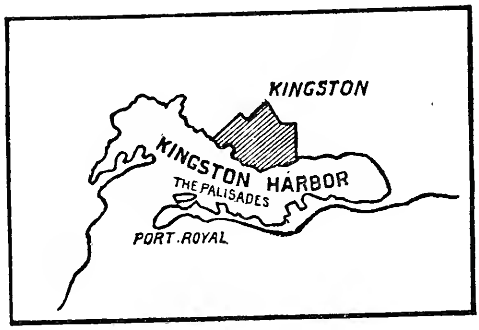
THE popular notion of the great catastrophe which overtook the city of Port Royal, Jamaica, in the year 1692, is that the earth yawned open, taking in the unfortunate city, as it were at one gulp, and that the next minute the sea flowed several fathoms deep over the spot where it had stood. Connected with this notion is the belief, which has been sedulously inculcated by several generations of religious writers, that the catastrophe was a signal instance of divine wrath; that, in fact, the city was swallowed up on account of the desperate wickedness of its inhabitants—the buccaneers and their associates. It is somewhat strange that in this age of investigation and research no one should have yet come forward to dispel some of the illusions with which ignorance and superstition have clothed this great disaster; for we may confidently affirm that the earth did not yawn open and swallow up the town of Port Royal, which was destroyed in a perfectly natural and comprehensible manner; and to those persons who profess to be exponents of divine motives we may point out that Port Royal was not overwhelmed when it was the resort of the buccaneers and the dissolute and profligate of both sexes, but at least fifteen years after these gentry had been expelled from Jamaica, and had removed their headquarters to the French portion of Hispaniola.

The former city of Port Royal stood where the present town now stands, at the western extremity of the long tongue of sand, called "The Palisades," which incloses the harbor of Kingston on the southern side. Its area in 1692 was much the same as it is now; for, except on the northern side, where the church buoy marks the site of the submerged cathedral, the action of the tides has in a great measure repaired the damage committed by the earthquake. The accompanying map will enable the reader to see its situation and surroundings at a glance.

The sand-spit, some nine miles in length, called "The Palisades," at the extremity of which Port Royal stands, owes its existence to

a number of small cays of Æolian formation, which, originally detached, have now been joined together by ridges of sand. This formation is still going on to the southward, and an outer line, similar to the Palisades, is gradually being built up on the numerous small detached cays which lie between East and Southeast Cays.

When the Spaniards discovered Jamaica the present Palisades were in much the same condition as the outer line is now—that is to say, there was a line of detached cays, connected by banks of loose, shifting sand, which were submerged at high water, with here and there channels of sufficient depth to admit of the passage of small vessels. In 1635, when Colonel Jackson, the English adventurer, attacked and plundered St. Jago de la Vega, the capital of Jamaica, the small cay of calcareous rock, which ultimately became the nucleus of Port Royal, was separated from the Palisades by a channel sufficiently deep for his ships to pass through. Twenty years later, when Venables captured the island from the Spaniards, this channel was closed by a narrow bank of sand barely rising above the water, and those who had accompanied the former expedition remarked upon the change which had taken place. From that date the sand seems to have accumulated rapidly, and before long the Palisades became one continuous tongue of sand, extending from the mainland of the island on the east to Port Royal Point on the west.



The Spaniards, during the century and a half that they held Jamaica, never erected any buildings upon Cagua, or Punto de Caguaya, as the cay at the western extremity of the Palisades was termed by them.* Indeed, in their day the site was not at all suitable, for during the prevalence of strong breezes the sand was swept hither and thither by the sea, and a great portion of the cay submerged. After, however, the cay had become joined to the Palisades, and the sand ridge had risen two or three feet above high water, Cagua, or Careening Point, as the English called it, became a good position from which to defend the entrance of the harbor. The first work, which mounted twenty-one small guns, but consisted merely of a stockade with a wall of

* This name is supposed to be a corruption of *caragua*, the Indian name for the aloe.

loose stones, was erected in 1656, and in 1657 this was replaced by a round tower of stone. The requirements of the small garrison gradually led to houses being built, and Governor Brayne formed a naval and military depot. Thus by degrees a town sprang up, which at first was limited to the rock area of the original cay, but which gradualy overflowed those limits and spread along the sand which had drifted up against the rock. In 1660, at the accession of Charles II, the royal commission confirming in the office of Governor of Jamaica Colonel D'Oyley, who had been appointed under the Commonwealth, was proclaimed at Careening Point, and the town was named Port Royal, in commemoration of the event. In 1662 the stone tower, which had been enlarged and added to, was similarly renamed, and henceforward was known as Fort Charles.

At about this time the buccaneers began to frequent Port Royal, bringing there their prizes and plunder, and the prodigality and excess of these gentry drew a number of dissolute characters to the town. The buccaneers themselves formed no inconsiderable number. Morgan, the English (or, rather, Welsh) leader, had under his command twenty-eight English vessels, carrying one hundred and eighty guns and thirteen hundred and twenty-six men, and eight French vessels with fifty-nine guns and five hundred and twenty men, and there were several other independent leaders. The wealth they brought into Port Royal was enormous. After the sack of Puerto Velo, the successful buccaneers returned to Jamaica and divided the spoil on Port Royal beach. "Two hundred and fifty thousand pieces of eight were divided among them, and plate, jewels, and rich effects were piled up beneath the eaves of the houses for want of warehouse room. This quickly changed hands, and after a few weeks of riotous debauchery the buccaneers were again poor, and clamoring to be led to sack another town. . . . Many of the inhabitants of Port Royal were literally rolling in wealth. Their tables and dinner services were of silver, and their horses were sometimes shod with plates of the same metal, loosely nailed, so as to drop off and show their contempt of riches. Vast wealth, intermingled with the sound of arms and the riot of intemperance, filled the streets."

Esquimeling, the historian of the buccaneers, who was bondservant to the notorious Morgan, has left us a strange picture of Port Royal at that day. After narrating a successful exploit, he continues: "All these prizes they carried into Jamaica, where they safely arrived, and, according to their custom, wasted in a few days in taverns and stews all they had gotten by giving themselves to all manner of debauchery, with strumpets and wine. Such of these pirates are found who will spend two or three thou-

sand pieces of eight in one night, not leaving themselves, peradventure, a good shirt to wear on their backs in the morning. . . . My own master would buy on like occasions a whole pipe of wine, and, placing it in the streets, would force every one that passed by to drink with him, threatening also to pistol them in case they would not do it. At other times he would do the same with barrels of ale or beer. And very often, with both his hands, he would throw these liquors about the streets and wet the cloaths of such as walked by, without regarding whether he spoiled their apparel or not, were they men or women."

To Port Royal, consequently, flocked thousands of people, all anxious to profit by the wild extravagance of the buccaneers, and new houses sprang up until all the available space was covered. Then rows of palisades were driven a few feet into the sand at the water's edge, sand was brought from a distance and banked up behind them, and houses built on the foundation thus made. As the demand for greater space increased, such encroachments became more common, until the greater portion of the town was built upon made ground, which was merely kept in position by a succession of rows of stakes or palisades, and which any severe shock of earthquake would inevitably shake down. And this was done, not on a flat beach shelving gradually through shallow into deep water, but on the brink of a harbor so deep that the largest ships of the day could lie close in shore, sometimes even with their yards projecting over the roofs of the houses. It was simply courting destruction.

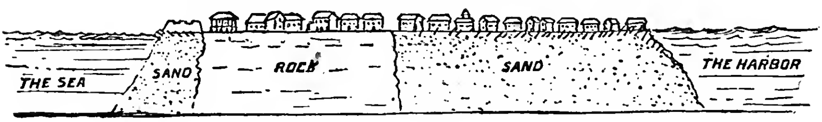
However, we are anticipating, for the end was not yet. The buccaneers continued to frequent Port Royal, in spite of orders sent out by the British ministers to the Governor of Jamaica to restrain their excesses, and the plunder of Maracaibo, Panama, and scores of less important places was brought into the town. The buccaneers were in fact the masters of the situation, for the Jamaica government had no force with which it could compel respect for its orders—that is to say, if it gave any orders, for there are good reasons for supposing that everybody was disposed to connive at a system by which everybody profited. At last, however, the remonstrances of the court of Spain took effect: in 1672 all commissions and letters-of-marque that had been granted to buccaneers were revoked, and Port Royal ceased to be their chief resort, though for the next two or three years occasional prizes were brought in by stealth. With the departure of the buccaneers the town declined; and when Sir Hans Sloane visited it in 1687, although it contained some two thousand houses, the population was only between three and four thousand. The bulk of the inhabitants had no doubt followed the fortunes of the buccaneers, but the town was still the largest and most populous in

Jamaica, all the others, with the exception of Spanish Town, being mere hamlets.

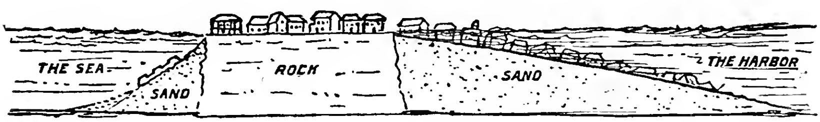
Let us now take a general view of the town as it was a year or two before the earthquake. In the center, approximately speaking, built on the solid rock of the original cay, was Fort Charles and about five streets of houses, while all around, but principally to the north, and to the east, where the ship-channel had been when Colonel Jackson visited the island, the greater part of the houses were built upon ground that had been won from the sea, and was retained in position by rows of palisades. These latter were most numerous to the east, and that part of the town was called the Palisadoes, whence we get the modern name "The Palisades." Several batteries and other works had been built on the brink of the water on land similarly won from the sea. Of these the principal were Fort Rupert, a hexagonal work, defending the approach along the sand-spit from the east; Fort James, which mounted thirteen guns, and was situated at the northwestern angle of the town; Walker's Lines, which commanded the entrance to the harbor; and Morgan's Lines, which defended the sea front. The ground-floors of the houses were, generally speaking, of brick; the upper portions of wood. Four fifths of the town was thus built upon sand, heaped up on the verge of deep water, and it is marvelous how the inhabitants could have been satisfied to live in so perilous a position, for earthquakes frequently took place, and they had ample warning of what might at any time occur. On October 20, 1687, a shock of earthquake was felt which caused the bells in the church to ring and a tidal wave to sweep along the streets nearest the harbor, while the sand in other streets, sucked out by the waters beneath, fell away into crater-like pits. Nobody, however, seems to have inquired what would have been the result had the shock been of longer duration.

The 7th of June, 1692, the day of the great earthquake, was exceedingly hot; not a cloud was in the sky, and not a breath of air stirred. At about 11.40 A. M. a slight trembling of the earth was felt, and this was shortly followed by a second shock, somewhat stronger than the first, and accompanied by a hollow rumbling noise like distant thunder. At this most of the people began to run out of their houses, but a third shock at once supervened, and in about a minute—for it is said to have lasted nearly a minute—four fifths of the town was in ruins and the sea rolling over it. The streets on the north side, on the brink of the harbor, where the sand had been most steeply banked up, were the first to fall, sinking at once into four or five fathoms of water; next fell the church and tower; and then Morgan's Lines, on the south side, on the verge of the sea, to which many had fled for safety,

suddenly disappeared, the sea rolling completely over the place where it had stood. Then the whole of that portion of the town where the ship-channel had been sank at once into deep water, while the houses nearer the central rock sank, some up to the eaves, others up to the first floor, and others again one or two feet only, according to the distance at which they were situated from the water's edge. The shock of the earthquake, in fact, shook down the artificially sustained bank of sand; as the sand shook down and spread out, the houses subsided, while the sea, rushing in underneath as well as above, gushed up in spouts in the streets and completed the ruin. Fort Charles and the houses that stood on the rock foundation alone remained, and of these the greater number were terribly shattered. About sixteen hundred persons are said to have perished. The following sketches, showing roughly a section of Port Royal, before and after the earthquake, will help to explain what occurred.



BEFORE.



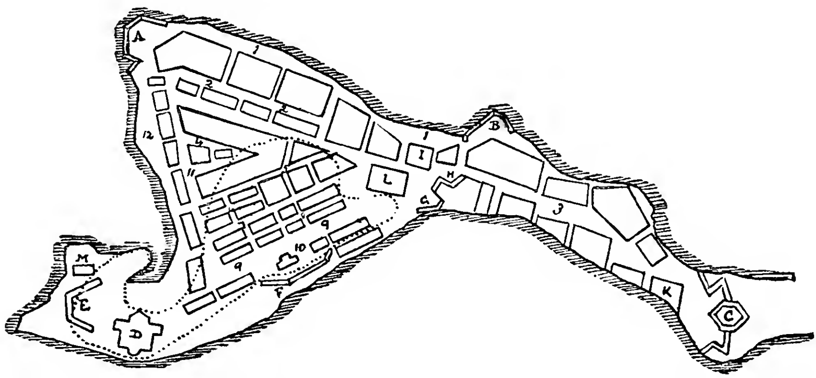
AFTER.

The amount of damage done by an earthquake to buildings depends very largely upon the nature of the foundations, for the shock-waves of earthquakes travel at different rates of speed through different substances. As a rule it may be said that the more compact the substance the quicker the rate. Thus they travel fastest through solid rock and slowest through loose sand. The duration of the shock has everything to do with the amount of damage; consequently, in Port Royal, the sand gave way, and the houses built on it collapsed, while those built on the rock, though evidently shaken and thrown out of the perpendicular, remained standing.

We are able to append the following curious map, which is said to be an exact plan of Port Royal before the earthquake, and which shows what remained afterward. It must be observed, however, that the cathedral-church, which stood near the building known as King's House, is unaccountably omitted. The original is to be found in the library of the Institute of Jamaica, at Kingston. The dotted line shows the area of rock.

A few descriptions of the earthquake by eye-witnesses are still extant. We take the two following, which may be of interest, from the Philosophical Transactions, vols. xvii, xviii, 1694:

1. "This part of Port Royal which is now standing, is said to stand upon a rock. . . . It seems strange that the force of the earthquake did not dissipate and dissolve the very foundation of it, and that it did not fall to pieces and scatter under the water, as the rest of the place did; for the shock was so violent that it threw people down on their knees, and sometimes on their face, as they run along the street to provide for their safety; and it was a very difficult matter to keep one's legs. The ground heaved and swelled like a rolling, swelling sea ('tis a strange comparison, but everybody here using it, I venture to do so likewise), by which means several houses now standing were shuffled and moved some



AN EXACT PLAN OF THE TOWN OF PORT ROYAL BEFORE THE EARTHQUAKE IN 1692; THE PART WITHIN THE DOTTED LINE BEING ALL THAT WAS LEFT AFTER THE SHOCK.

A, Fort James; B, Fort Carlisle; C, Fort Rupert; D, Fort Charles; E, Walker's Lines; F, Morgan's Lines; G, White's Lines; H, Church Lines; I, King's House; K, School; L, New Dockyard; M. Storehouse. 1, Thames Street; 2, Queen's Street; 3, High Street; 4, Broad Street; 5, New Street; 6, Cannon Street; 7, York Street; 8, Tower Street; 9, Church Street; 10, Parade; 11, Lime Street; 12, Fisher's Street.

yards from their places. One whole street (a great many houses whereof are now standing) is said to be twice as broad now as before the earthquake; and in many places the ground would crackle and open, and shut quick and fast: of which small openings I have heard Major Kelly and. others say they have seen two or three hundred at one time, in some whereof many people were swallowed up; some the earth caught by the middle and squeezed to death; the heads of others only appeared above ground; some were swallowed quite down, and cast up again by great quantities of water; others went down and were never more seen. These were the smallest openings; others that were more large, swallowed up great houses; and out of some gapings would issue whole rivers of water, spouted up a great height into the air,

which seemed to threaten a deluge to that part of Port Royal which the earthquake seemed to favor, accompanied with ill stenches and offensive smells. . . . The sky, which was before clear and blue, was in a minute's time become dull and reddish, looking (as I have heard it compared often) like a red-hot oven: all these dreadful circumstances occurring at once, accompanied all the while with prodigious loud noises from the mountains, occasioned by their falling, etc.; and also a hollow noise underground, and people running from one place to another distracted with fear, looking like so many ghosts, and more resembling the dead than the living, made the whole so terrible, that people thought the desolation of the whole frame of the world was at hand. Indeed, 'tis enough to raise melancholy thoughts in a man now, to see the chimneys and tops of some houses, and the masts of ships and sloops, which partak'd of the same fate, appear above water; and when one first comes ashore, to see so many heaps of ruins, many whereof by their largeness shew that once there had stood a brave house; to see so many houses shatter'd, some half fallen down, the rest desolate and without inhabitants; to see where houses have been swallowed up, some appearing half above ground, and of others the chimneys only; but above all to stand on the sea-shore, and to look over that part of the neck of land which for above a quarter of a mile was quite swallowed up; there where once brave streets of stately houses stood, appearing now nothing but water, except here and there a chimney."

2. "What you desire concerning our earthquake in Jamaica, I will answer as near as I can to what I saw and heard; Port Royal being the place where I lived. I shall begin with what I met with there. On Tuesday, the 7th of June, 1692, betwixt eleven and twelve at noon, I being at a tavern, we felt the house shake, and saw the bricks begin to rise in the floor, and at the same instant heard one in the street cry, 'An earthquake!' Immediately we run out of the house, where we saw all people with lifted-up hands begging God's assistance. We continued running up the street, whilst on either side of us, we saw the houses, some swallowed up, others thrown on heaps; the sand in the street rose like waves of the sea, lifting up all persons that stood upon it, and immediately dropping down into pits; and at the same instant a flood of water breaking in and rowling those poor souls over and over; some catching hold of beams and rafters of houses, others were found in the sand that appeared when the water was drained away, with their legs and arms out; we beholding this dismal sight. The small piece of ground whereon sixteen or eighteen of us stood (praised be God) did not sink. As soon as the violent shake was over, every man was desirous to know if any part of his family were left alive. I endeavoured to go towards my house

upon the ruins of the houses that were floating upon the water, but could not; at length I got a canoa, and row'd up the great sea-side towards my house, where I saw several men and women floating upon the wreck out to sea; and as many of them as I could I took into the boat, and still row'd on till I came to where I thought my house had stood, but could not hear of neither my wife nor family. But seeing all people endeavouring to get to the island, I went among them, in hopes I might hear of my wife, or some part of my family, but could not. Next morning I went from one ship to another, till at length it pleased God that I met with my wife and two of my negroes. I then asked her how she escaped. She told me, when she felt the house shake, she ran out and call'd all within to do the same. She was no sooner out but the sand lifted her up; and her negro woman grasping about her, they both dropped into the earth together; and at the same instant the water coming in, rowl'd them over and over, till at length they catch'd hold of a beam, where they hung, till a boat came from a Spanish vessel and took them up. The houses from the Jews' street end to the breastwork were all shak'd down save only eight or ten that remained from the balcony upwards above water. And as soon as the violent earthquake was over, the watermen and sailors did not stick to plunder those houses; and in the time of their plunder one or two of them fell upon their heads by a second earthquake, where they were lost. . . . Several ships and sloops were over-set and lost in the harbour. Amongst the rest the Swan-Frigat that lay by the wharf to careen, by the violent motion of the sea and sinking of the wharf, was forced over the tops of many houses: and passing by that house where my Lord Puke lived, part of it fell upon her, and beat in her round-house: she did not over-set, but helpt some hundreds in saving their lives."

The shocks of earthquake continued, but with decreasing violence, for a period of nearly three weeks, and the survivors of the catastrophe at Port Royal fled to the plain of the Liguanea and encamped where the city of Kingston now stands. Here they were attacked by a pestilence, occasioned by exposure, scarcity of food, and the effluvium from the corpses which were floating up and down all over the harbor. Jamaica historians tell us that this epidemic "slew thousands of the survivors," but as they have limited the population of Port Royal to thirty-five hundred, and sixteen hundred of these perished in the earthquake, there were no thousands left to be slain. From a letter, dated Jamaica, September 20, 1692, it appears that about five hundred died.

Other portions of the island were more sensibly affected by the shock than was even Port Royal, and it is said that the elevation of the entire surface was considerably diminished. More houses were left standing in Port Royal than in all the rest of

the island put together, for scarcely a planter's house or sugar-works withstood the shock anywhere. Not one house remained standing in the village of Passage Fort, one only in the Liguanea, and none in Spanish Town but a few low and substantial structures that had been built by the Spaniards. From the Saltpond Hill, opposite Port Royal, water rushed out from some twenty or thirty openings, twenty feet above the sea-level, and continued running abundantly for two days. Vast land-slips stripped the mountain-sides of their forest, and left bald and bare scarps several miles in extent. Rivers were choked up and driven into new channels, and the entire appearance of the Blue Mountain Range was changed.

As far as Port Royal was concerned, the earthquake had reduced it to a cay of about the same dimensions as it presented in 1635 when Colonel Jackson visited Jamaica, and the work of fifty-seven years had been undone in one or two minutes. Although Port Royal is now again connected with the Palisades, the process of silting up does not appear to have proceeded so rapidly after the earthquake as it did before. In 1698 there was still a navigable channel over the ruins, for on the 8th of November of that year a committee of the House of Assembly reported: "That it is necessary to have a close fort of about sixteen guns erected upon the easternmost part of Port Royal, where the old church and King's House stood, which will not only secure the passage which the late dreadful earthquake made on that part of the town, but very much annoy any ship that may break into the harbour." As late as 1783—that is, ninety-one years after the earthquake—Port Royal is referred to in official documents as a "cay."

Sixty years ago the ruins of the submerged town were said to have been plainly visible in calm weather, and at the present day irregular masses of masonry can be discerned near the conical red buoy which marks the spot where the church stood. The popular belief, derived from the works of old authors, such as Martin's British Colonies, was that incalculable wealth was to be found among the ruins; for, according to these writers, "the wharves were laden with the richest merchandise, and the markets and stores displayed the glittering spoils of Mexico and Peru," at the time that the earthquake occurred. This, no doubt, was only meant for fine writing, as we know very well that the wealth and glory of Port Royal had departed some fifteen years before the catastrophe; but it served to inflame the public imagination, and in 1861 an American diver requested aid from the Government to explore the remains of the old city, offering to divide the treasure he might find. One trial was allowed him. He stated, on coming to the surface, that he had entered what was apparently a blacksmith's shop, and that he had found the remains of a fort,

presumably Fort Carlisle, but that he had been unable to enter it, it being entirely overgrown with coral, which had imbedded the guns in the embrasures as firmly as if they had been fixed in solid masonry. It was probably at this time that one of the bells of the old church, which is now in the Museum of the Jamaica Institute, was recovered.

At Green Bay, opposite Port Royal, concealed in dense bush, is the tomb of Lewis Galdy, a member of the Assembly of Port Royal, who fell into one of the crater-like pits caused by the subsidence of the sand, and was washed out again by the water gushing up from beneath. The inscription, which is rapidly becoming illegible, is as follows: "Here lies the body of Lewis Galdy, Esquire, who departed this life at Port Royal, the 22d of December, 1736, aged eighty years. He was born at Montpellier, in France, but left that country for his religion, and came to settle in this island; where he was swallowed up in the great earthquake in the year 1692; and, by the Providence of God, was, by another shock, thrown into the sea, and miraculously saved by swimming, until a boat took him up. He lived many years after in great reputation, beloved by all who knew him, and much lamented at his death."

As we have said, owing to the action of the tides and currents, the sand has again accumulated round the nucleus of rock at Port Royal, which presents, physically, much the same appearance as it did before the earthquake; and, notwithstanding the lesson of the past, the surface is again crowded with buildings. But what has happened once may at any time happen again; shocks of earthquake frequently occur in Jamaica, and it only requires one of sufficient violence to bring upon the new town the fate which overtook the old. Let us hope, however, that it will not occur.

Among the marked characteristics of the Melanesians, as described in Dr. R. H. Codrington's book about them, is the universal prevalence of secret societies, like the Duk-duk of New Britain, the Matambala of Florida Island, the Quatu of the New Hebrides, and the Tamate of the Banks Islands, which celebrated certain mysteries and peculiar dances, kept secret from the uninitiated and from women and girls, but having nothing religious, obscene, or idolatrous about them. The Banks Islands are considered by Dr. Codrington the chief seat of these societies, which are there called "The Ghosts." All these Tamate associations have as their particular badge a leaf or flower. The lodge or secret resort of the Tamate is the *salagoro*, established in some secluded place, generally amid lofty trees, in the neighborhood of every considerable village or group of villages. The whole place is set apart, not sacred, by sufficient authority, and no woman or uninitiated person would think of approaching it; yet foreigners are admitted without difficulty. These Tamate have survived the introduction of Christianity. All belief in the supernatural character of the associations has long since disappeared, but the societies occupied so important a place in the social arrangements of the people that they have held their ground as clubs.

RAPID TRANSIT.

LESSONS FROM THE CENSUS. VI.

By CARROLL D. WRIGHT, A.M.,
UNITED STATES COMMISSIONER OF LABOR.

WE have seen that the population of cities is rapidly gaining in proportion to the increase of population in the whole country, and also that this growth in cities is largely suburban in its character. The suburban growth is fed from without and from within. As business is extended, and the room and area formerly occupied by people are taken for great mercantile houses and for manufacturing, the population of such areas is sent out to the suburbs of necessity, while many seek suburban residences as a matter of choice. From without the suburban population is augmented by the rush to cities from the country. Owing to the improvement in methods of agriculture, by which production from the earth becomes in some sense a manufacture, a less number of persons is required for agricultural purposes than of old. The question is often asked why, if population increases, there is not an increasing necessity of supplying food products; and if there is such a necessity, why can great numbers be spared from the rural districts to engage in the business undertakings of the cities? Improved methods of production offer an answer to this question, the result being that the labor of the country not being in so great demand, even to supply the vast increase required in food products, seeks remunerative employment in centers of population. As the contraction of labor through invention goes on, the expansion of labor through invention grows to a greater extent; and it is probably true that through inventions, or through great industries which have come into being in recent years, a larger number of people are employed relatively than are deprived of employment through improved methods. The great industries associated with electrics, railroad enterprises, the building of new kinds of machinery, and the absorbing in various ways of laborers in occupations not known until within a few years, enables manufacturing centers to furnish gainful work to those coming from the country, where, relatively speaking, they are not needed. These people take up their residence in the suburbs, though they may find their occupations in the crowded areas of the cities themselves. The question of rapid transit in cities, therefore, becomes one not only of great interest in the study of the movement of population at the present time, but one of prime necessity for the consideration of municipal governments. It is something more than a question of economics or of business convenience; it is a social and an ethical question as well.

The bulletins of the census furnish, to some extent, the statistics relating to rapid transit in cities, and of the relative economy of different motive powers used on street railways. These bulletins have been prepared by Mr. Charles H. Cooley, special agent for rapid transit facilities in cities, under the immediate direction of that skillful statistician and economist, Mr. Henry C. Adams, special agent for transportation, and from them we learn the growth of rapid transit facilities during the ten years from 1880 to 1889, inclusive, in cities having over fifty thousand inhabitants. The special experts have selected cities on a basis of an estimate of population made at the time the compilation of the tables was begun.

The full reports of the statistics of the equipment of all roads furnishing rapid transit facilities, and of their operations for the single fiscal year ending 1890, are being collected, and the census authorities will present them in future exhibits.

Prof. Adams announces, and with truth, that street railways have never before been brought within the scope of the census statistics of transportation, and he points out the peculiar difficulties which were met with in collecting the facts already presented. Some of these difficulties arose from the ambiguity of designation, as "length of line," "length of single track," and "length of double track," when applied to street railways; and on account of such ambiguities the attempt has been made to fix upon some definite nomenclature by which careful returns can be secured. The conclusion is, that "length of line" means length of road-bed, or, in case of railways running entirely upon streets, the length of street occupied; that "length of single track" means the length of that portion of the road-bed or street laid with one track only; and that "length of double track" means the length of that portion of the road-bed or street laid with two tracks. In determining the total length of tracks, switches and sidings have been included, and thus double track has been reckoned as two tracks.

On December 31, 1889, 476 cities and towns in the United States possessed rapid transit facilities, the total number of railways in independent operation being 807. Many railroads, however (and the number is stated at 286, having a total length of 3,150·93 miles, and 13, having a total length of 135·75 miles), have as yet made no report; while in six the returns received were so imperfect that it was necessary to supplement them by approximations. This statement accounts for the bulletins not presenting statistics for a series of years for the whole number of railroads in the country, and 56 cities have been selected for which the reports are comparatively complete. Suburban lines tributary to large cities, but without their corporate limits, as well as

those actually within the cities, are included in the statement; as, for instance, where cities situated close together have a common street-railway system, it has not been thought best by the experts to attempt a separation in the tables. Therefore, Pittsburg and Allegheny, in Pennsylvania, are treated as one city, as are also Newark and Elizabeth, in New Jersey. The street-railway lines comprehended in Boston traverse also Lynn, Cambridge, and other suburban places.

The aggregate mileage of the fifty-six cities selected for each year from 1880 to 1889, with the increase and percentage of increase, is shown in the following table:

Year.	Total mileage.	Increase.	
		Miles.	Per cent.
1880	1,689·54	......	.....
1881	1,765·95	76·41	4·52
1882	1,875·10	109·15	6·18
1883	1,941·49	66·39	3·54
1884	2,031·84	90·35	4·65
1885	2,149·66	117·82	5·80
1886	2,289·91	140·25	6·52
1887	2,597·16	307·25	13·42
1888	2,854·94	257·78	9·93
1889	3,150·93	295·99	10·37
Total	....	1,461·39	86·50

It is only fair to state that in order to make the foregoing statement, the statistics of some of the cities have been re-enforced by information from sources other than the census returns.

By the above table it will be seen that from 1,689·54, total mileage in the fifty-six cities selected in 1880, the growth has been to 3,150·93 miles in 1889. This is an increase of 1,461·39 miles, or 86·50 per cent. These figures show conclusively the rapidly increasing wants of cities.

The five leading cities of the country have a mileage assigned them as follows: Philadelphia, 283·47; Boston, 200·86; Chicago, 184·78; New York, 177·10; Brooklyn, 164·44. These are figures for 1889, and they show the total length of line; but the total length of all tracks, including sidings, for the same cities, is as follows: New York, 368·62; Chicago, 365·50; Boston, 329·47; Brooklyn, 324·63; Philadelphia, 324·21. From these figures we find that the position of Philadelphia in the last statement is reversed, and that New York steps from the fourth place in the five cities named to the first place; and this brings out a peculiarity of the Philadelphia roads and, to some extent, the roads of Boston, the tracks in these cities, to a large extent, occupying different streets in going to and from a terminus instead of being laid upon the same street.

The motive power used on the total mileage given is divided as follows:

Motive Power.	Miles.	Per cent.
Animal power	2,351·10	74·62
Electricity	260·36	8·26
Cable	255·87	8·12
Steam (elevated roads)	61·79	1·96
Steam (surface roads)	221·81	7·04
Total	3,150·93	100·00

The relative economy of cable, electric, and animal motive power has been brought out by the census officers, but the superintendent remarks, in issuing the bulletins on this subject, that it is still too early to form a final judgment regarding the value of electric motive power for street railways; yet he feels that the statistics presented, being, as they are, a record of actual experience, throw considerable light upon the matter of economy. The lack of uniform accounts of railways prevents the use of the data already collected for the formation of a final judgment; while, again, the electric railways, being nearly all new, have not been in operation a sufficient length of time to afford final conclusions as to economy of service; and, as Prof. Adams points out, most electric railways are the successors of roads operated by horses, the horses being still retained on a part of the lines and the expense incurred for horse power being intermixed with that incurred for electric power. For these reasons a final judgment on the figures given must not be reached; yet the facts presented are indicative of what may be expected.

The bulletin relating to the relative economy of different motive powers embraces fifty lines of street railway, ten of which are operated by cable, ten by electricity, and thirty by animal power; and from the various tables presented, showing length, steepest grade, number of cars, car mileage, number of passengers carried, operating expenses, etc., a crystallized statement (which statement, it should be remembered, is not a complete and accurate one) is drawn, showing that the operating expense per car mile of cable railways is 14·12 cents; of electric railways, 13·21 cents; and of animal power, 18·16 cents; while the operating expense per passenger carried is, for cable railways, 3·22 cents; for electric railways, 3·82 cents; and for railways operated by animal power, 3·67 cents. It will surprise many to learn that in operation both cable and electric railways show a greater economy than railways operated by animal power; but in the full tables given in the bulletins it is noticeable that electric railways which have the least expense per car mile have the greatest expense per passenger carried. So the statement of the ratio be-

tween passengers carried and car mileage becomes essential, and from this it appears that electric railways show a less number of passengers per car mile than either of the other classes, the number of passengers carried per car mile being, for cable railways, 4·38; for electric railways, 3·46; and for railways operated by animal power, 4·95. Thus the electric railways carry a less number of passengers per car mile than either of those operated by cable or by animal power. The assumption is made in the census report that this variation is explained by the fact that electric roads, being new, occupy lines over which the passenger traffic has been but partly developed.

The expense per car mile and per passenger, the cost of road and equipment, and the volume of passenger traffic are essential for a full understanding of the financial side of the question. From the statistics reported it is seen that the total cost of road and equipment per mile of line (meaning thereby street length) is, for cable railways, $350,324.40; for electric railways, $46,697.59; and for railways operated by animal power, $71,387.38; and the number of passengers carried per mile per year is, for cable railways, 1,355,965; for electric railways, 222,648; and for railways operated by animal power, 596,563. From these figures it appears to be true that cable railways attain their greatest efficiency where an extremely heavy traffic is to be handled, and that electric railways and those operated by animal power are used where the traffic is not so heavy, or is more generally diffused.

The operating expense per car mile is: For cable railways, 14·12 cents; for electric railways, 13·21 cents; for railways operated by animal power, 18·16 cents; and the operating expense per passenger carried is, for the different powers as named, respectively, 3·22 cents, 3·82 cents, and 3·67 cents; but, including interest charge per car mile at assumed rate of six per cent, the sum of operating expense and interest per car mile is: For cable railways, 20·91 cents; for electric railways, 17·56 cents; and for railways operated by animal power, 21·71 cents. These charges, both actual and estimated, show a somewhat greater expense for cable roads per car mile than for electric roads; but when the interest charge is considered on the basis of passengers carried, and added to the operating expense, the sum of operating expense and interest per passenger is as follows: For cable railways, 4·77 cents; for electric railways, 5·08 cents; for railways operated by animal power, 4·39 cents, showing a less cost for operating expense and interest charge per passenger for cable railways than for electric railways. In the first instance, the greater charge for cable railways is on account of the much greater cost and equipment per mile; while the greater number of passengers carried by cable railways per mile reduces the ratio of expense on the passenger basis.

It is to be hoped that the complete statistics relating to rapid transit in cities will enable the public to determine, with reasonable accuracy, the relative economy of the different powers used. This is a question which is vital to the interests of city and suburban communities, and which leads to the ethical consideration of the problem of rapid transit. That power must eventually be used by which passengers can be transported from their homes to their places of business and return at the least possible expense, and the greatest possible safety commensurate with high speed.

The necessity of living in sanitary localities, in moral and well-regulated communities, where children can have all the advantages of church and school, of light and air, becomes more and more evident as municipal governments undertake to solve the problems that are pressing upon them. If it be desirable to distribute the population of congested districts through country districts, means must be provided for safe, rapid, and cheap transit to the country districts; or, inversely, if it be desirable to build up the suburban areas, the people must be supplied with cheap and convenient means of reaching the localities within which they earn their living.

The reduction of fares, through improved means of rapid transit, however desirable, is really a minor question. It is probably true that by a slight reduction from a five-cent fare the head of a family engaged in mechanical labor, earning perhaps five or six hundred dollars per annum, might save enough to pay taxes, or to offset church and society assessments, or to furnish his family with boots and shoes, in any event extending his power *pro tanto* for the elevation of his family; but he does more than this when speed is taken into consideration. By the old methods of transit from suburbs to the heart of a city a working-man going into the city of Boston was practically obliged, while working ten hours at his usual occupation, to spend an hour on the horse-railway, when now, on one line, by the use of the electric car, he can go to and return from his place of work in half that time, thereby actually adding to his own time half an hour each day, practically reducing his working time from eleven hours to ten and a half hours without reduction of wages and without increased expense for transportation. The question of rapid transit, therefore, as seen by this simple illustration, becomes an ethical consideration; for if there is anything to be gained by adding to the time which men have at their disposal for their own purposes, for intercourse with their families, for social improvement, for everything for which leisure is supposed to be used, then the question of rapid transit is one of far greater importance than that of saving money either to the man who uses transportation or to the company that secures dividends upon its stock. I be-

lieve, therefore, that all the efforts that are being made to secure convenient and cheap rapid transit in great cities are those which should bring to their support the help of all men who are seeking the improvement of the condition of the masses.

Business extension in cities is crowding the street area. This area is precisely the same in old cities like Boston, New York, Philadelphia, etc., for the present population and business operations that existed a century ago. The crowding of streets with the transportation essential for the movement of goods increases with great rapidity, but when the crowding is augmented, perhaps doubled, by the presence of the means of transporting passengers, the difficulties involved are almost appalling. With every increase of population the companies having in charge transportation facilities must, in order to accommodate the public, add more cars and more animals—if animals are the motive power—and so rapidly add to the already crowded condition of streets. This process is one which attacks the health and the safety of the people. The presence of so many horses constantly moving through the streets is a very serious matter. The vitiation of the air by the presence of so many animals is alone a sufficient reason for their removal, while the clogged condition of the streets impedes business, whether carried on with teams or on foot, and involves the safety of life and limb. It is a positive necessity, therefore, from this point of view alone, that the problems connected with rapid transit should be speedily solved, and this feature demands the efforts and the support of sanitarians. With the removal of tracks from the surface, and with tunnels built in such a manner as to be free from the dampness of the old form of tunnel, as has been done in London, and to secure light and air and be easy of access, all the unsanitary conditions of street-railway traffic will be at once and forever removed; and if private capital can not be interested to a sufficient extent to undertake such measures, then municipal governments must see to it that the health of the community is not endangered by surface traffic. When this question is allied to the ethical one, and when one considers the advantages to be gained, first, through securing rapid transit from the crowded portions of cities to the suburbs, and, second, by removing rapid transit traffic from the surface to underground viaducts, the importance of the whole problem becomes clearly apparent, and not only the importance of the problem but the necessity of its solution.

The statistics given by the census officers seem to indicate that as a matter of economy the very best equipment can be used without increasing the tax upon individual passengers. If underground roads can be used without at first increasing such tax, and still offer a reasonable compensation for capital invested, the

gains to the people at large offer an inducement to capital, while the many considerations of health and morals offer men who desire to use their means for the benefit of their kind an opportunity that has not existed in the past. From my knowledge of some of the men who have been foremost in projecting lines of rapid transit, but who have been accused of doing it for entirely selfish motives, I learn that public benevolence has influenced them to a sufficient extent to induce them to take the great risks which are apparently involved. I believe that could the real, underlying patriotism of such men be known, and the confidence of the public in their willingness to do work for the public benefit gained, the solution of the rapid transit problem would be much easier.

Capital is securing less and less margin of profit through its investments, whether in manufacturing or in other enterprises. The capitalist is satisfied with a safe and sure return of from three to five per cent, and the spirit of altruism, which seems to be growing more and more rapidly among our millionaires, and which is leading them to the establishment of great institutions for public good, will lead them ultimately to such operations as those essential to secure the best results of rapid transit. Private capital, encouraged and protected by public sentiment and municipal enactments, may be capable of solving this problem. If it is not, then public sentiment, interested in the welfare of the people at large, not only from an economic point of view, but from sanitary and ethical considerations, will insist upon a public solution of the question. It is an important study, and the officers of the eleventh census are entitled to great credit for their efforts to bring out the partial results they have published, and, later, to give to the country the full data relative to rapid transit in cities.

In a paper on the Meteorological Results of the Challenger Expedition in relation to Physical Geography, Mr. Alexander Buchan expresses the conclusion that the isobaric maps show in the clearest and most conclusive manner that the distribution of the pressure of the earth's atmosphere is determined by the geographical distribution of land and water, in their varying relation to the heat of the sun through the months of the year; and since the relative pressure determines the direction and force of the prevailing winds, and these, in their turn, the temperature, moisture, and rainfall, and in a very great degree the surface currents of the ocean, it is evident that there is here a principle applicable, not merely to the present state of the earth, but also to different distributions of land and water in past times. In truth, it is only by the aid of this principle that any rational attempt, based on causes having a purely terrestrial origin, can be made toward the explanation of those glacial and warm geological epochs through which the climates of northern countries have passed. Hence the geologist must familiarize himself with the nature of these climatic changes, which necessarily result from different distributions of land and water, especially those changes which influence most powerfully the life of the globe.

ORCHESTRAL MUSICAL INSTRUMENTS.

By DANIEL SPILLANE.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XIV.

THE most profound and intellectual works of the great masters in the symphony and other forms of "instrumental" music—as they are classified in musical nomenclature—are interpreted through the orchestra, and through forms partly dramatic and vocal, such as opera and oratorio, in which the orchestra and various combinations of orchestral instruments play an important and inseparable part. Orchestral music is also an indispensable auxiliary to the proper representation of melodrama and in other departments of dramatic art.

Within the past forty years, especially since the close of the civil war, the progress of music in America has been most remarkable. This is manifest to-day in the large number of fine orchestras, musical societies and bodies throughout the country, and in the intelligent and generous support given to representations of the best class of music. A great demand has in consequence grown up for instruments for orchestral and band purposes. Many of these—for instance, the harp, violin, flute, violoncello, and cornet—being also largely used for private amusement at home and in small musical circles, their production gives employment to a large number of skilled workmen, and maintains a comparatively new and expanding American industry.

Though bands do not serve the high artistic purposes of orchestras—some full military bands, such as Gilmore's, Cappa's, and Sousa's, may be excepted—they fill an acknowledged place in the domain of the art. Bands have been associated with popular demonstrations since the earliest times, though originally in crude forms. In the illustrations of ancient Assyrian and Egyptian sculptures, given in the February issue in relation to the article on the piano-forte in this series, may be seen the precursors of modern band musicians marching in procession with lyres, dulcimers, harps, double flutes, and pulsatile instruments to commemorate some notable event, which indicates the fact that the human instinct which finds its expression in the maintenance of bands at this date is as old as the most remote chapter in the history of civilization. As compared with our instruments of music, however, these products of the Assyrians, Egyptians, and other nations of the far-away past were little more than toys. This remark applies equally to the instruments in use among the Greeks and Romans of a more recent period.

I fancy that Plato, Aristotle, and other philosophers of those

times must have had a fashion of drawing largely upon their imagination, or else some elements of human nature must have changed since then, for they all remarked the influence of music upon the manners of a people. If the crude musical system they were acquainted with, with its primitive instruments, was capable of such effects as they claimed, an interesting proposition is suggested for some student to elaborate—namely, are the people of the present less sensitive and less open to the influence of music—though having an incomparably superior system—than the ancients? This remains for some speculative and subtle mind to determine. Lyres, cithares, and incidental stringed instruments of that order have meanwhile become obsolete, while the dulcimer has no place in art. The harp has, however, come down to us through the centuries in an enlarged and vastly improved form as the most honored and most historic of all musical instruments. It is not so important, indeed, as the piano and parlor organ, and consequently could not have been treated in our previous articles with consistency, although it was a precursor, in its primitive forms, of the piano-forte and entitled to mention.

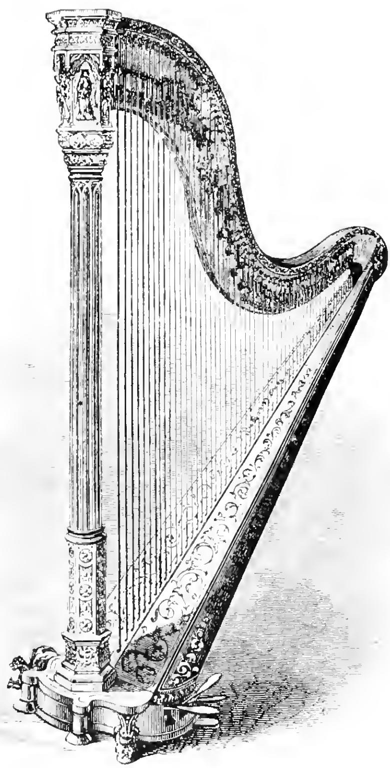


Fig. 1.—Modern Double-pedal Harp.

The harp in its present form is capable of fine artistic effects, and is in most respects far different from the rude instrument of that species known in remote centuries. There are many kinds of harps produced, namely, the Welsh harp, which contains three rows of strings; the double harp, having two rows; the single-action pedal instrument and the double-action pedal harp, with one set—the latter being the most successful and artistic instrument of all. In fact, the single- and double-action pedal harps are generally used in musical circles to the exclusion of the two former.

Among the races identified with the improvement of this ancient instrument the Celts are entitled to first mention, the Irish and Welsh being in particular associated with it in the pages of history and romance. It still occupies a place in the festivals of the latter nation. Owing to the use of gut strings, the tones produced are more mellow and sympathetic than those of the piano, but this one advantage can not compensate for the various other disadvantages on its side as compared with the piano; that is, for popular use. What is not the case with the piano, the performer must be able to string and tune the harp. It gets out of tune rapidly, while the method of playing it calls for considerable expertness in the performer, owing to the absence of finger-keys and other mechanical conditions familiar in the piano.

The harp only became worthy of a place in the orchestra toward the end of the last century, when Southwell, of Dublin, and Erard, of Paris, invented the modern pedal-action system. Hochbrucker and Volter, German makers, made some notable changes in its construction about 1730, but until the invention of the system referred to it was not acceptable to musicians of culture.

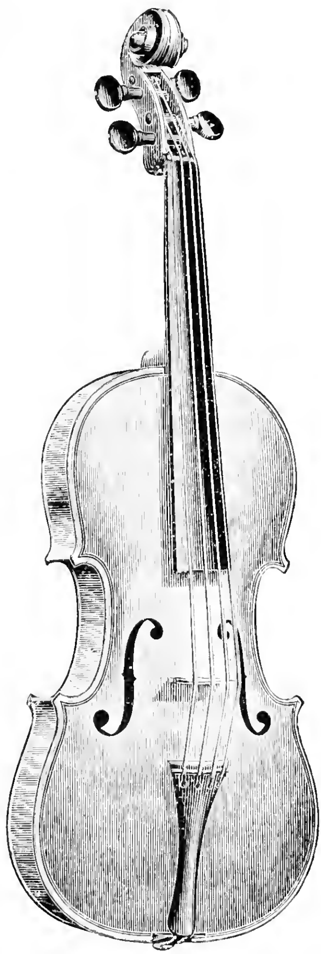


Fig. 2.—Violin, Amati Model.

The name of Erard ranks first in Europe to-day, after the lapse of a century, among harp-makers, but there are several other manufacturers of note in Berlin, Paris, and London, who produce instruments of the first grade. The pedal-action system of Erard enables the performer to raise the pitch of each string two semitones mechanically, which facilitates execution and effect to a wonderful degree. Harps were made in this country as far back as 1790. In that year Charles Watts, of New York, exhibited instruments of his own construction, but they met with little demand. For over a half-century harp-makers have existed here in a few cities, but up to about fifteen years ago the instrument had a very limited circle of patrons. Brown and Buckwell are the

most time-honored names of American harp manufacturers—names best known to persons interested in this artistic branch. Comparatively little in the way of radical inventions has been introduced into the instrument since Southwell's and Erard's improvements were adopted, but a gradual development has taken place, the present concert harp being capable of larger and more extended tones and art possibilities than those instruments used in past years. Many native artists, among whom Miss Maud Morgan and Miss Inez Caruzi may be mentioned, have already appeared in America, while in the leading conservatories throughout the country professors of the harp are also engaged, and this educational work is steadily widening the circle of its admirers and patrons. James F. Buckwell, of New York, has introduced some improvements in the instruments of his manufacture; these can not be very readily described, however. Lyon & Healy, of Chicago, have also begun the manufacture of harps containing many patented points of improvement. One of the chief points of originality in the Lyon & Healy harps is the adjustment of the pedal-rods. These work in solid metal bearings in the column, and are a remarkable improvement over ordinary methods. In these instruments many other original features in the action and parts are also evidenced, and these permit the performer to make the most perfect mechanical adjustment of the scales in the various pedal positions ever made possible in the harp. A comparison of American harps on the whole with foreign instruments will go to show that they are equal in every respect, if not superior in some details.

Orchestral and Band Instruments.—The violin and instruments of that order rule in the orchestra. Although bow instruments somewhat similar were known long before Christ, the violin of the familiar shape only came into use about the middle of the sixteenth century. One Baltazarini gave performances to wondering listeners in England in 1577, which is the earliest record known. The elder Amati began business in Cremona, Italy, in 1600, and is said to have founded that famous school. The Stradivari and Guarneri families subsequently appeared and bequeathed to the world instruments which are famous to-day. Germany, which claims to have first produced the violin, is represented by the names of Klotz and Steiner, who flourished during the same century. The violin became the leader in the orchestra, and still holds the foremost place there. The violoncello and other larger forms of the instrument were evolved between the middle of the sixteenth and the end of the seventeenth century, but nearly all effort has been concentrated on the violin, or "little viol," from which the familiar title came.

Dr. F. W. Adams, of Montpelier, Vermont, was perhaps the

most noted of early American makers. He was in the field in 1820. The first makers of instruments of the violin family were Benjamin Chrehore, of Milton, Mass., spoken of in connection with pianoforte-making, also Clement Claus, of New York, who came from London in 1790. Samuel Long, of Hanover, N. H., won considerable notoriety from 1812 to 1825 in that field; while Abraham Prescott, of Concord, N. H., took the place of the latter and became equally esteemed. Among the most famous were Warren A. White, of Boston, and Calvin Baker, of Weymouth, Mass., both more recent makers than Long and Prescott. Nearly all the violins turned out by those domestic violin-makers mentioned went among amateurs and into unpretentious orchestral circles. The professional musicians had always a preference for old instruments, and these of necessity came from abroad.

But within the past thirty years American violins fully equal to the best European instruments of modern times have been produced, some of which will be ranked with the finest examples of the Cremona masters in future years. These have come from the workshops of the Gemunders. George Gemunder is a native of

Fig. 3.—Improved Flute, Boehm Model.

Germany, where he was born in 1816, but he has lived here since 1847, almost a half-century, and is the only American violin-maker that exhibited in the musical instrument department of the famous World's Fair in London in 1851. He learned the art of violin-making from his father, and at nineteen became a pupil of Voillaume, in Paris, where he stayed four years. He began business in Boston in 1847, and in 1851 removed to New York, where he has since been located. August Gemunder is equally a renowned maker, his instruments being in the hands of some of the leading soloists. He was also born in Germany, but has been here since early manhood. Lesser makers in various cities produce good violins, while nearly all manufacture violas, violoncellos, and basses as well.

The modern transverse flute, passing over its precursors, was invented in Germany in the seventeenth century; hence the term "German flute." It was first used by Handel in orchestral scores, and speedily achieved a leading place, although up to recent years a very imperfect instrument. In its present perfected state it is very satisfactory, and capable of producing excellent artistic effects. The piccolo, a smaller species, has also come into being, and is employed in conjunction with the other in orchestras and bands. The latter is capable of producing the sharpest and highest tones known in the compass of any instrument. The flageolet

is the ancient form of the flute—with some differences—and is also used very widely.

The flute was first made acceptable for artistic requirements by Theobold Boehm about 1834. Not only did this celebrated inventor contribute to the flute, but his system of key adjustment, fingering, and tube-boring materially assisted the further development of the clarionet and other wood wind-instruments. He was anticipated in this country, however, in many points by Edward Riley, one of the earliest American musical instrument makers of the century. Boehm was a native of Munich, Germany, where he had a shop devoted to the making of wood wind-instruments. Captain Gordon, a Swiss military officer of Scotch extraction, was the inventor of the Boehm system of fingering, but Boehm applied it practically with modifications in 1835, and thus earned the credit of being the inventor. He crossed to London in that year and introduced his instruments to musicians, meeting with great success. These were made with the cylindrical instead of the conical bore and created much attention. Their appearance led to a revolution in the methods of flute-making practiced up to that period. Boehm took out no patent, hence the general adoption of his method of boring and other particulars soon after their introduction. His system of fingering in itself, however, involved a radical departure which musicians and students were loath to take up at once, but it is now firmly established.

Common flutes without keys were made in America before the Revolution, but Riley was the first maker of standing to appear in the field. He had a factory in Franklin Square, New York, as early as 1810, where he produced wood wind-instruments of various kinds for orchestral and band purposes. The firm of Firth & Hall came into existence about 1817, and was devoted to the

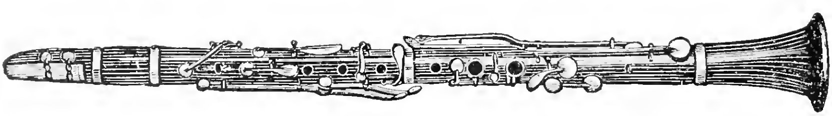


Fig. 4.—Clarionet, with Improved System of Fingering and Key Construction.

manufacture of wood wind-instruments and music-publishing. Thaddeus B. Firth, of Maspeth, Long Island, a grandson of John Firth, yet carries on flute-making as a special branch, in which he has won some distinction. Flutes, flageolets, and piccolos of excellent quality are manufactured by various makers in this country at present, in connection with clarionets and other wood wind-instruments.

The clarionet, which plays a most important part in the domain of musical art, is a product of Germany, where it was invented in

1690 by Denner, of Nuremberg. It resembles the oboe in the structure of the tube, but sound is produced in it by means of a single instead of a double reed. Like all the instruments treated, it was very imperfect up to thirty years ago. It occupies the place of the orchestral violin in reed—ordinarily called military—bands. Meanwhile, the clarionet was not an "invention" in the exact sense, owing to the fact that it had a predecessor of the oboe family known as the *schalmey* or *chalameau* (from calamus, a reed). J. C. Bach, son of the master, first introduced it to

FIG. 5.—THE BASSOON, AN IMPORTANT AUXILIARY IN ORCHESTRAS AND MILITARY BANDS.

notice in his opera of Orione, in 1760, and its general adoption followed. It was given a leading place, in military bands in particular, as a treble instrument from the moment of its inception. Within the past half-century larger forms of the instrument appeared—alto, tenor, barytone, and bass—for military band purposes, their artistic use being to soften the brasses and lend color to the *ensemble* and to special effects.

Saxophones are a production of this century, and indispensable in full reed or military bands. They are played with a clarionet mouthpiece, and resemble the clarionet, only that they are made of brass instead of wood. Saxophones are the invention of the celebrated Antoine Sax, of sax-horn and musical-instrument fame. While working in his father's shop, in Dinant, Belgium—in which city he was born in 1814—he conceived the idea of their construction. Settling in Paris in 1842, Sax won a leading place as a maker of wood and brass wind-instruments. He secured a patent for his saxophones in 1846, and in time introduced them into the French military bands, other nations acquiring them subsequently. They have been improved largely since their production, and, though not ranking high as solo instruments, they enjoy an important place in large bands as instruments essential to artistic aims in *ensemble*.

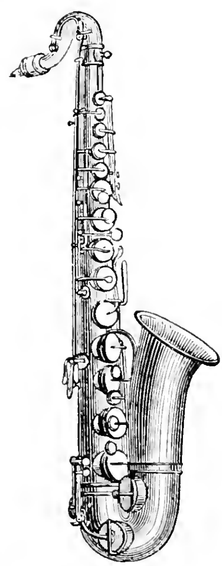


FIG. 6.—SAXOPHONE.

We arrive now at brass instruments, such as the horn and cornet, in which sound is produced by means of the lips vibrating in the mouth-piece. To readers acquainted with the common bugle the principle will be easily apparent. The origin of the

horn is lost in antiquity. It is the parent—in its native form without pistons—of the numerous family of piston and slide instruments which have been evolved within the past century, and it is one of the relics of the past, which has maintained a place in the modern orchestra or military band through the addition of valves. The instrument in question is known at present as the French horn, to distinguish it from the sax-horn and the

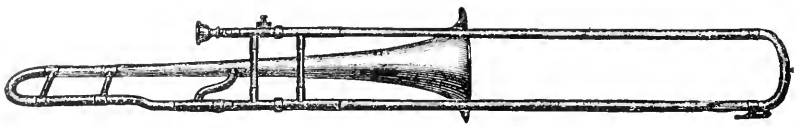


Fig. 7.—Slide Trombone.

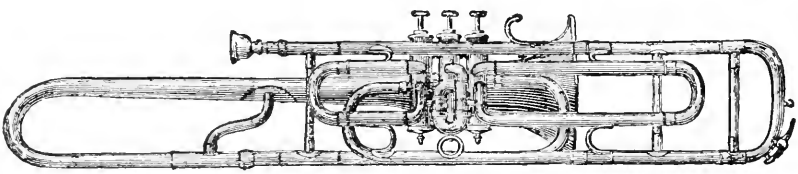


Fig. 8.—Valved Trombone.

English horn. When Beethoven first wrote for it in the orchestra it was in its primitive state, the tones produced being those of the harmonics of the open tube. These are doubtless familiar to most readers who have heard military bugles. Intermediate tones were produced by the insertion of the hand in the bell of the instrument at first, which muffled the tone and so rendered the effect uneven in *timbre* and not acceptable for solo purposes. The introduction of pistons, about 1840, obviated the former drawbacks, but its normal tone-character renders it useful merely as an accessory, for it is too soft, subdued, and lacking in individuality to win a place as a solo instrument.

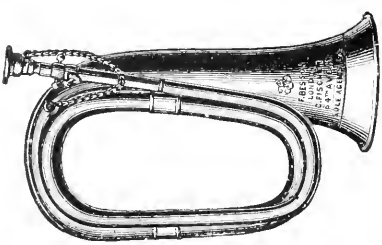


Fig. 9.—Duty Bugle, the Precursor of the Cornet.

The slide trombone and trumpet are equally ancient in their primitive shape. The former yet maintains a leading place. Besides the harmonics of the open tube referred to, intermediate semitones, so as to complete the range of the accepted octave, are easily produced in the trombone by means of the slide, which lengthens or decreases the tubing as required. Since valves were invented, they have been applied to the latter, but the slide trombone is yet preferred, owing to the superior purity of its tones,

which, however, hardly compensates for defectiveness in phrasing and other drawbacks.

Up to about 1840 the keyed or "Kent bugle" held the place now occupied by the cornet, although in being only since 1807. That now obsolete instrument was the familiar duty or field bugle, to which keys had been added so as to allow the production of intermediate tones in addition to the harmonics indicated.

Halliday, an Irish gentleman, who invented that instrument, discovered by accident that, by boring holes in an old field bugle, extra tones could be produced. Ellard, a musical instrument maker of Dublin, made him a model after some experiments, and the latter having added further improvements, it was submitted to the Duke of Kent, who introduced it into his band, whereupon it took the name of the "Kent bugle."

When the allied armies entered Paris after Waterloo, the Grand Duke Constantine of Russia heard the bugle for the first time. Through Distin—father of the modern family of that name—then soloist in the Coldstream Guards band, he secured a copy, and on returning to Russia had it adopted in all the imperial bands. It had a short existence, however, for within a few years the cornopean—as the cornet was at first named—succeeded it. This was not merely an incidental step beyond the Kent bugle, for it resulted in the production of a complete family of brass instruments within a few years, namely sax-horns, besides influencing the French horn, trombone, and trumpet, and art generally. It appeared first in Russia, but its invention was claimed by the elder Sax, and by a Mr. Adams, an American. The latter had no patent and never proved his right to the claim advanced, while the representations of Sax stand equally discredited. The real author is yet unknown. The chief features of originality in the cornopean or cornet over the keyed bugle consist in the use of three pistons, which, on being pressed singly, or in combination, shut off, or add, certain lengths of tubing, so as to raise or lower the pitch, these valves being perforated to assist that end.

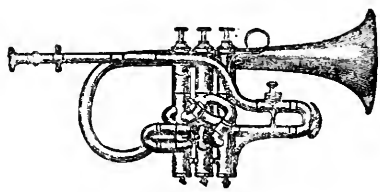


Fig. 10.—Soprano Cornet.

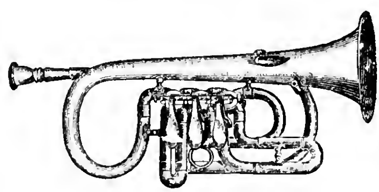


Fig. 11.—Cornet, showing Rotary Valve System.

Antoine Sax, of Paris—the greatest inventor of the age in that field—in addition to his feats in relation to the saxophone, took

the cornet in its crude state, regulated the tube lengths, cut away rough angles in the air-passages of the valves, and made it more acceptable for artistic needs. It became popular immediately, the great Koenig and other artists appearing before 1850 to give it notoriety. In 1846 Sax also introduced his sax-horns, from soprano to bass, which were adopted in all countries, with special improvements and modifications. The brass bands of modern character—called "cornet bands" in some parts of this country—therefore became a possibility. In sax-horns and more recent adaptations of these instruments, such as the circular basses and euphonium, the same piston system prevails as in the cornet.

Bands were chiefly used for military purposes up to about 1840, when amateur and professional organizations for public celebrations appeared.

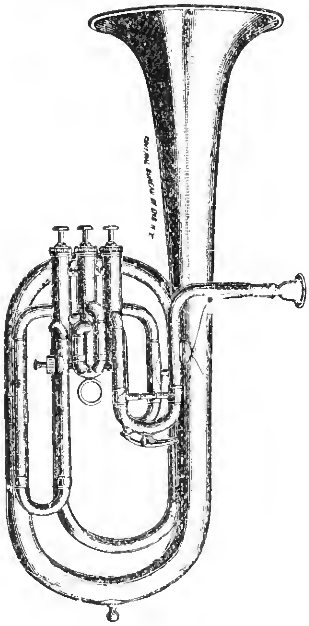


Fig. 12.—Tenor Sax-horn.

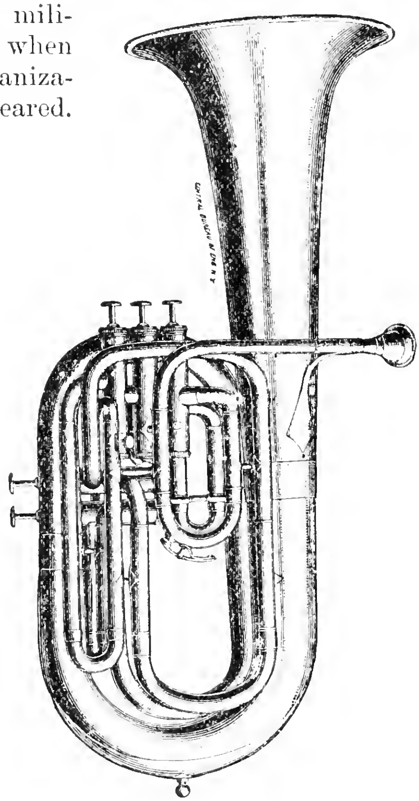


Fig. 13.—Bass Sax-horn.

Previous to the appearance of the clarionet they were composed of hautboys, sackbuts, trumpets, flutes, serpents, horns, and various other obsolete instruments, all of a crude character, besides drums, cymbals, and pulsatile accessories. Yet the invention and adoption of sax-horns in military bands gave rise to an entirely new order of instrumentation in the abstract, but without disturbing the clarionet from the position it has always occupied.

The manufacture of brass wind-instruments in America was be-

gun about 1835, but the few bands then in the country constituted the market to be relied upon. American bands, and the spread of the cornet and other brass instruments among private parties which increased after the war period, helped to maintain a few small manufactories devoted to the cheaper variety, until about the great Centennial Exhibition year, when Henry Distin, son of John Distin spoken of above, removed from England and began to manufacture the justly celebrated "Distin" instruments in the United States. The Distins had been previously in business in London for a great many years, and had won a leading place in that sphere. Henry Distin's arrival here practically established that industry in this country.

A notable sign of the progress going forward in this art and industrial channel is the town of Elkhart, Indiana, the mainstay of which is a manufactory founded by C. G. Conn, devoted to military band instruments of a high order, which are fast winning a leading place. Mr. Conn established himself in business in 1883 upon an enlarged scale after being burned out; he had been only a few years in the field at the time. The Distin factory is situated in Williamsport, Pa. Several other smaller makers of the cheaper class of musical instruments are scattered throughout the country.

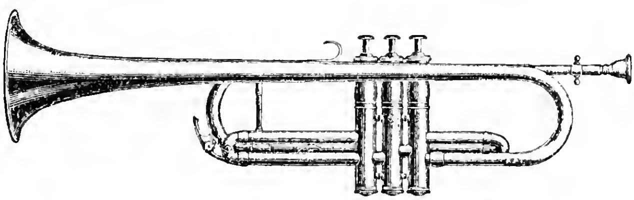


FIG. 14.—MODERN VALVED TRUMPET.

In addition to the branch treated, Lyon & Healy, of Chicago, Haynes & Co., of Boston, and Stratton & Co., of New York, maintain factories devoted to the production of guitars, mandolins, and small instruments of that order, which give employment to a large number of hands. These industries being of very recent growth, it is impossible to give any comparative estimate of their progress in the absence of the statistics for 1890, which has not yet appeared. The table for 1880 would in itself be no guide, for the above reason.

Meanwhile it is a source of satisfaction to know that such activity prevails in relation to musical art in America as the articles throughout indicate. It also shows that Americans, as a people, are wonderfully versatile, and capable of establishing industries which are maintained as specialties in countries abroad, while capable of improving almost everything which they undertake to manufacture. That has been distinctly shown in the music industries at least.

VARIATIONS IN CLIMATE.

By W. H. LARRABEE.

SPECULATIONS concerning changes of climate have an interest that never flags. It rarely happens in the succession of seasons that two of an identical character come in succession; and any more than usually marked variation easily prompts the fancy that some modification in the character of the climate is impending.

The subject of climatology is a difficult one. The data for the proper study of it have hardly begun to be collected. We are embarrassed when we undertake to define climate and what marks to accept as its characteristics. Hann and Humboldt define it as comprising the whole of the meteorological phenomena characterizing the state of the atmosphere at any place, particularly as they affect our organs or have an influence on animal or vegetable life. The general character of the conditions can not be determined by the observations of one year, for they are liable to be contradicted by those of the next year; nor by those of any short term of years, for a similar reason. A period must be taken long enough to furnish the data for composing a type; and the more the years vary, as between one another, the longer must the period be. Many factors enter into the composition of a climate and form complicated combinations, all of which must be unraveled so as to give each factor its true force and position; and then the determination of their relative importance affords another source of embarrassment. Temperature and moisture are accepted as the most important factors, and temperature as the dominant one; and the climate is deduced by considering the average mean temperature for a term of years. Equal yearly averages do not, however, signify identical climate. A place where the summer heat and the winter cold are extreme has not the same climate as one where the range is relatively narrow, though the yearly averages may be the same in both. Hence we need separate determinations of summer and winter averages. The combinations of conditions of temperature and moisture may be endless, while the averages of either may be hardly disturbed. These facts make it hard to compare climates even when they are steady for long periods. In the capricious climates of our temperate latitudes a just determination and comparison form a baffling task.

Observations, more or less systematic, with instruments, have been made of climatological features for about a hundred years, but on a general co-operative plan they have been carried on imperfectly for less than a third of that time, or about the period

within which some observers suppose a round of meteorological changes is accomplished for a single locality. Popular opinions are founded most largely on hap-hazard recollections of vague impressions that can not be depended upon; and even if we had accurate records in place of these, they could not be used to determine the trend of climate on account of the short time they cover. It has happened more than once during that time that a series of seasons of a peculiarly marked character has been followed abruptly by a series of opposite character, nullifying the conclusions that may have been taking shape from the former series. The speculations concerning a decrease of rainfall in the United States in consequence of the removal of the forests have been disturbed by the recent prevalence, in part of the disforested area, of a succession of seasons of heavy and continuous rains.

Cosmical revolutions and changes taking place on the surface of the earth have been mentioned as causes by which climates may be permanently modified, and have been brought in to account for the changes which geology shows have taken place in the past.

Among the theories of cosmical causes, one, which supposes the solar system to be carried through parts of space having different constitutions or different temperatures, may be dismissed as being purely hypothetical. No fact has been adduced in support of it, and no valid reason has been presented for supposing that there are differences in the parts of space. Other theories, which refer climatic changes to astronomical cycles affecting the earth's orbit and its position therein, have a more substantial basis. They have been considered by sober authors and have a hold on the minds of intelligent students; and the cycles have a real existence and are capable of producing effects that can be calculated. They comprise a secular variation in the obliquity of the ecliptic; the precession of the equinoxes, with the attendant revolution of the apsides; and an oscillation in the eccentricity of the earth's orbit—all conforming to regular and well-defined periods.

The variation in the obliquity of the ecliptic affects the distance to which the sun departs from the equinoctial at midsummer and midwinter. Its action is to heighten or reduce the contrast between those seasons according as its measure is greater or less. By precession the equinoctial points shift their places backward along the ecliptic, accomplishing a revolution in 21,500 years. It entails the revolution of the apsides, which is equivalent to a displacement in relation to the seasons of the points of the earth's greatest and of its least distance from the sun. By the variation in the eccentricity of the earth's orbit these distances, called the aphelion and perihelion distances, are lengthened and shortened, the difference between them is increased and diminished,

and the quantity of heat received from the sun by the earth in different parts of its orbit is supposed to be correspondingly modified. These differences are greatest when the eccentricity is greatest. If with this is combined such a position of the equinoxes that summer in one hemisphere shall correspond with the perihelion and winter with the aphelion, the contrast of the seasons in that hemisphere will be most marked, and we shall have the conditions, according to one theory, for a glacial period.

Such, according to M. Jean Reynaud, was the case in the northern hemisphere about 9500 B. C., when, he thinks, our last glacial period was at its height. From that time the differences were gradually reduced till about 1250 A. D., when they became least, and the northern seasons were mildest and most equable. The differences then began to enlarge again, and we are now advanced a little more than six hundred years toward another glacial period. According to this theory, the seasons were growing milder all through human history till 1250 A. D., and have been tending to become more severe since then.

A question of fact is here presented, evidence respecting which is sought, in the absence of exact observations, in such records as may happen to exist of the character of seasons in the past. M. Arago several years ago collected a considerable list of mentions in the literature and documents of former times of periods of unusual cold, of long or cold winters, unusually hard freezing of rivers, and remarkable heat, drought, or rain, which constitutes our principal source of information on the subject. Parts of this list have been used by M. Jules Peroche and M. Amadée Guillemin to establish opposite conclusions as to the validity of M. Reynaud's hypothesis.

Latin poets furnish some of these data, as when Ovid complains of the inclemency of his place of exile on the Black Sea, in what is now pleasant southern Russia; or Horace and his compeers describe terrible storms in Rome; or Juvenal tells of a Roman lady having to break the ice of the Tiber to wash her face. Cicero and some of the historians speak of the severe climates of Gaul and other outlying provinces, evidently contrasting them with the pleasures of life in Italy. The discomforts experienced by Hannibal in crossing the Alps were what an army from the south would suffer in any age in crossing those mountains in winter, if they were roadless and inhabited by barbarians. To a candid critic, these representations mean nothing on one side or the other, and such is the conclusion which M. Angot has reached after carefully examining the subject.

Of fifty-six instances of extreme winter severity cited by M. Peroche from M. Arago's list, fourteen occurred before the supposed "Great Summer" year, 1250. There seem to be more of

them as we approach the nineteenth century, but we have a right to assume that that is because the records are fuller near our times, not necessarily because extremes are growing more frequent or marked. None of the instances, ancient or modern, betoken greater severity than the frosts of 1234—sixteen years before the "Great Summer" year—when "the Po and Rhône were frozen, and loaded wagons crossed the Adriatic on the ice opposite Venice"; 1236, when "the Danube was frozen to the bottom for a considerable time"; or 1305, fifty-five years after it, when "the Rhône and all the rivers of France were frozen." With all the greater completeness and systematic organization of modern observations, the records of the nineteenth century contain no mention of such seasons as those of 1323, 1333, 1349, 1402, and 1407, when the southern part of the Baltic was frozen so hard that men could ride on horseback from Copenhagen to Lubeck and Dantsic.

These occasional winters of exceptional severity can not be taken as typical of the general character of the seasons, any more than we can characterize a winter by an extreme day in January, or a summer by an unusually sultry July day winding up in a thunder-shower. A surer guide to the habitual climate would be afforded by regarding the development of plant growth and the maturing of crops. Of these the vine has been taken as a type. It is said that, cultivated in the time of Julius Cæsar only in the southern parts of Gaul, or France, it was gradually carried northward to the fullest expansion in the thirteenth century, when there were vineyards and wine was made as far north as Flanders and England. Since then it has retired from the most northern points it had reached, where the grape is now ripened under glass. So the cultivation of the olive is said to be falling back toward the south; the sugar-cane has disappeared from Provence, where it once grew; less tender plants are taking the place of the orange in some quarters; and a depression of the zone of forest vegetation is mentioned as taking place in the Alps and the Carpathians.

There are many other causes than climate, as the present operations of agriculture and horticulture amply demonstrate, by which the cultivation of a crop in any place is determined. It may be found after some years of experiment to be unprofitable or of poor quality there; or may be supplanted by new and better varieties growing in more favored localities, or superseded by the introduction of new and more profitable products, which the cultivator is always ready to take up. Such causes have more force now than they ever had before, because of the great increase in the facilities for exchange under which it is no longer necessary to cultivate anything except in the places where it will do best. M. Angot has, moreover, found, by consulting the offi-

cial records of the times of the opening of the vintages as far back as to the fourteenth century, that there has been no real change. The times have varied in the same places, in different years or series of years, during all this period, as much as two months, but there has been no regular variation, or any of a character to support the hypothesis of a constant, secular movement.

M. Arago undertook, about fifty years ago, to measure the value of these cosmical influences on climate, and declared that they were not competent to produce an effect within the period of historical time worthy to be regarded. He found that the present effect upon the surface of the cooling of the earth's interior, which some were disposed to regard, could be comprised within a thirtieth of a degree. Sir William Thomson makes it still less, and limits it to one seventy-fifth of a degree. M. Arago saw no reason for supposing there were differences of temperature in the parts of space, while, if there were, they would affect all the earth alike and not one hemisphere more than another. The variation in the obliquity of the ecliptic, small in its total at the most, could not cause a change of more than a quarter of a degree in two thousand years.

M. Arago likewise depreciated the importance of the precession of the equinoxes and the variation in the eccentricity of the earth's orbit as climatological factors, because, as he showed, during a period of long eccentricity with summer at the perihelion, while the hemisphere may receive a more intense heat during the summer part of the revolution the excess is balanced by the season's being shorter; but the winter will under those conditions be both colder and longer. Sir John Herschel and M. Reynaud have answered him as to this point by saying that character is given to the season, not by the absolute quantity of heat received, but by its distribution; not its mean temperature but its maxima and mimima of temperature are to be considered, and the greater or less rapidity of the ascent and descent of thermic movements. A difference of four and a half times in eccentricity, such as is possible, might work great changes in these properties; so that in the case considered by M. Arago "half the annual heat would be concentrated into a summer of very short duration, while the other half would be distributed through a long and gloomy winter, made intolerable by the intensity of the cold, increasing in proportion to the distance of the sun." M. Arago thinks that it would take ten thousand years for variation in eccentricity to effect a change of temperature in the earth measurable by the thermometer. No evidence is produced that it has had any effect within the historical period.

Thus, whatever may be the importance of these astronomical causes in determining the climatic features of geological periods,

it is usually agreed that they may be disregarded in accounting for such changes as may have taken place within man's memory. Mr. James Croll, who has discussed this question with considerable fullness, and is inclined to allow them all the force they are entitled to, ascribes less importance to their direct operation than to the secondary effects they induce through their influence on the currents of the ocean and air and upon features of the earth's surface. M. Woeikoff allows them still less agency in the matter than Mr. Croll, and ascribes the greatest influence upon climate to the elevation and configuration of the land, as Mr. Lyell did in the earlier days of geology; and M. A. Blytt, of Christiania, has shown, by pertinent contemporaneous examples, how climate in Scandinavia may be influenced by slight differences in situation, soil, and exposure.

The whole subject has just been reviewed by Sir Robert S. Ball, Astronomer Royal of Ireland, one of the most eminent living mathematicians, in his book on The Cause of an Ice Age. Speaking particularly of Glacial periods, he shows that changes in the intensity of solar radiation, relatively unimportant to the sun, may produce enormous climatic effects on the earth. By an exact calculation he finds that, with the present obliquity of the ecliptic, while the earth as a whole receives equal amounts of heat from the sun during the two halves of the year, the distribution as to a single hemisphere is extremely unequal—a fact which previous writers seem to have overlooked—the exact distribution being sixty-three per cent of the whole amount of heat during the summer and thirty-seven per cent during the winter half. When the line of the equinoxes is perpendicular to the major axis of the earth's orbit and the eccentricity is at its maximum—the conditions establishing the greatest possible difference in the length of the seasons—the sixty-three per cent of heat is distributed over a very short and therefore intense summer, and the thirty-seven per cent over a long and therefore cold winter. The northern hemisphere, when placed in such a condition, will have a summer of one hundred and sixty-six days, during which the sun is at its least possible distance, and a winter of one hundred and ninety-nine days, with the sun at its greatest possible distance. This Prof. Ball regards as a condition favorable to glaciation. The ice and snow will accumulate during the rigors of the long winter, while the succeeding brief summer has not power enough to thaw as much water as has been solidified in the winter, and the ice will grow from year to year. All this time the southern hemisphere would be enjoying a widely different condition. Its summer would contain as great a number of days as it is possible for that season to possess, while the fierce heat of the sun would be abated from its average amount, because the sun would be at

the greatest distance from the earth it is possible for it to attain. The winter would be short and warm. The present difference in the length of the seasons is seven days, and the position of the perihelion is such that it is near its maximum for the present eccentricity. The directions in which the precession of the equinoxes and the variation of the obliquity of the ecliptic are tending are for reduction of the inequality, and ice ages are not to be expected from vicissitudes such as are now possible.

It is not denied that climates have been, and are, changing; but the changes are believed to be special, local, temporary, and oscillatory, and most largely determined by causes that may be found on the surface of the earth. M. Arago thought they might all be attributed to agricultural works, to the clearing of woods from plains and mountains, to the drying up of marshes; and he doubted if it could be proved that the climate had become warmer or colder in any place the physical aspect of which had not been perceptibly changed during a series of ages.

The present drift of the opinion of many careful students of the subject seems to be that exaggerated ideas have been held of the extent of climatic variations, both in the present and the past. M. Woeikoff, whose opportunities for studying climatological phenomena over a large extent of territory have not been surpassed, believes that this is so, even when the application is made to the Glacial period; that not intense cold, but those conditions of temperature and moisture most conducive to the precipitation and accumulation of snow, formed the chief factors of its characteristic phenomena. Chief among these were proximity of the sea and a temperature of the surface-water rather below than above the freezing-point. The effect on glacial accumulation of the conditions commonly supposed to correspond with the combination of high eccentricity and an aphelion winter would, in his opinion, be the opposite to what is attributed to it; for the greater cold assumed to prevail in winter would not be conducive to the precipitation of snow, while the more intense heat of midsummer would probably melt the snow at heights where the present temperature rises but little above the melting-point. Hence the conditions in the interior and eastern part of a continent like Asia would be less favorable than they are now to marked glaciation. The western parts of continents and islands would be more fully under the influence of the sea; and as there is no reason to suppose that its surface temperature would be lower than now, it follows that there would not, all other things being equal, be more snow than now in countries where rain is the rule, even in winter. The effect of the combination would be in any case but slight, and not by far, in M. Woeikoff's opinion, to be compared

to that of such geographical conditions as the distribution of land and sea, and of mountains and lowlands.

The idea that glaciation was dependent on extreme cold has been rejected by other students. J. de Charpentier recognized the conditions as inconsistent. Lecoq, of Clermont, "affirmed a correlation between a great solar heat, provoking a powerful evaporation, and the formation of glaciers." Tyndall has shown that the ice of the Alps "derives its origin from the heat of the sun," and that if that were diminished their source of supply would be cut off. The thoughts of some other writers, as Le Blanc, Forbes, and Charles Martins, have been turned to showing that the depression of temperature, if there was any, need not have been great.

Another group of writers, whose views have been summarized by M. Millot,* of Nancy, hold that warmer climates than now prevail were more favorable to glaciation, and gave character to the Glacial period; and that the present conditions of limited glaciation are the result of the sun's cooling, whereby the supply of evaporated moisture has fallen off. They claim that their theory furnishes the simplest explanation of the presence of warmth-loving plants and animals along with evidences of ice-action. The hot and the glaciated region were so close to one another that the mixture easily took place.

Prof. G. F. Becker, of the United States Geological Survey, has also expressed the opinion (Popular Science Monthly, February, 1884) that the Glacial period was one of higher mean temperature at the sea-level than the present; that while the formation of glaciers may have been affected by all contemporaneous changes, including secular revolutions, it is not necessary to have recourse to such causes; the question is chiefly one of differences between the temperatures at the sea-level and those at the level where the glacier was formed.

M. Blytt, studying the distribution of the Scandinavian fauna, has found it subject to considerable local variations at short distance, which have relation to differences in conditions of exposure and the character of the soil. He concludes that no great changes, but only small variations in the extremes of temperature and rainfall, are required to explain these departures. Such variations may be produced, for his country, by fluctuations in the direction, force, and temperature of ocean currents and winds that need in no case be great; but he believes that these variations are coincident with periodical changes of climate corresponding with secular incidents.

The considerable effects of exposure on local climates are

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* Popular Science Monthly, August, 1885.

exemplified at the winter seaside resorts on the south coast of England, where certain spots enjoying conditions of shelter from cold winds, combined with exposures favoring the concentration of the sun's rays and the warm winds upon them, enjoy a spring-like mildness through much of the winter. Prof. W. Mattieu Williams * speaks of Torbay, Torquay, Broadstairs, and Hastings as possessing these characteristics. A considerable difference has been noticed in the winter temperatures of places east and west of a certain point on the coast, though all are nearly in the same latitude.

Dr. D. Hart Merriam has described a succession of temperature zones in descending from the plateau level to the bottom of the Colorado Cañon equivalent to those stretching from the coniferous forests of northern Canada to the cactus plains of Mexico, with marked variations of climatic conditions under apparently very slight diversities of exposure.

A variation of only 5·3° Fahr. in the mean annual temperature at Uskfield, England, is shown by Mr. C. Leeson Prince † to be sufficient to exert an enormous influence on the general character of the seasons, the produce of the soil, and the health of the population.

The fact of changes in climate being admitted, discussion turns upon their extent, and the laws by which they are governed. In many cases they are brought about by changes in local conditions, of which the removal or replacement of forests, or the relations of land and water, are among the most important. In other cases a periodical law is supposed. The attempt has been made by some meteorologists and astronomers to show that there is a connection between such changes and an eleven-year period of abundance and scarcity of sun-spots. It was believed by an observer in Ceylon in 1872 ‡ that that island was on the eve of an important change of climate depending upon a cycle of thirty or thirty-five years. The previous thirty years, he asserted, had shown a complete contrast to the thirty years preceding them, with manifestly different effects on animal and vegetable life. It had been a period of relatively lighter rainfall, and the next cycle of thirty years was expected to be, above the average, wet. This theory of changes by thirty or thirty-six years is often met in following the discussions on this subject. A paper published recently in the *Archives des Sciences Physiques et Naturelles* # deduced from a total of twenty thousand years of observations, at about five hundred stations, that the climates of all the continents, excepting only a few maritime coast regions, were subject to simultaneous varia-

* Popular Science Monthly, March, 1886.

† Nature, vol. xx, p. 419.

‡ Nature, vol. v, p. 412.

Ciel et Terre, January 16, 1889.

tions, which became more and more pronounced toward the interior regions. The years 1815, 1850, and 1881 came about the middle of relatively wet periods, and 1830 and 1860 of dry periods. The mean period of the oscillations was deduced from records of vintages, going back to the year 1400, to be thirty-six years. The changes appeared to be dependent on certain relations of atmospheric pressure, the wet periods being characterized by lesser differences, and the dry periods by increased differences, in that factor. The theory of a period of thirty-five or thirty-six years is fully elaborated by Prof. E. Brückner, of the University of Basle, in his book *Klimaschwankungen* (Vienna and Olmutz, 1890). Approaching the question from nearly every conceivable point of view—of temperature, precipitation, atmospheric pressure, the rise and fall and freezing and thawing of rivers, vintages and harvests—he is led to the same conclusion in every case. The period is nearly equivalent to three of the supposed eleven-year sun-spot periods. Herr G. Hellman has counted thirty-four seasons since 1755 when December and January in Berlin were warmer than the average; but the warm seasons came at irregular intervals, and did not suggest any law.

Dr. W. Koppen, of Hamburg, records, as the outcome of an investigation which he made of the periodicity of weather-changes, "that for certain intervals strongly marked periodical influences make their appearance and then vanish entirely, at times being replaced by others of a totally different character. No law has, as yet, been discovered for these changes."

The presence of forests has not been shown to contribute directly to the increase of rainfall, nor their removal to diminish it. Yet their influence on climate must be considerable. This is confessed when the farmer on the prairies plants belts of trees between his fields and the quarters from which cold winds and destructive storms are expected. They stand like a wall to protect the localities they overhang against sudden extremes of temperature and other accidents of violent weather. Although they may not increase the amount of precipitation to a perceptible extent, they, by means of their matted roots and the undergrowth which they promote, and by their beneficent shade, convert the ground on which they stand into a kind of reservoir, and husband the moisture which, without them, would run off or dry up at once. Thus they contribute to prevent sudden floods in the wet season, and, permitting a slow exudation of moisture into the streams, to keep them lively and the rivers to which they are tributary full during dry seasons. Many persons believe, too, that they diffuse a coolness and vaporous moisture in the atmosphere, the presence and influence of which, although they are not manifested in rain, are nevertheless real. Whether they may

not exert an influence on the distribution of rain through the seasons, as they certainly do on that of ground moisture, does not appear to have been yet adequately investigated.

In connection with the influence upon climate of the relations of land and water, the speculations respecting the probable effect upon the climate of Europe of flooding the Desert of Sahara deserve to be noticed. It has usually been taken for granted that a cooler condition would follow. But Prof. Hennessey argued several years ago that, as vapor, rather than dry air, is the chief vehicle of wind-borne heat, the result would be the opposite of this. While the midday heats of the desert are intense, the nights are cold. Hence a uniformly warm breeze can not come from there. The warm southwest winds of central and southern Europe have been found to be connected with the currents of the Atlantic, and not to come from the desert. The substitution of water for barren sands and rocks would be followed by the storing up of the heat of the sun which is now partly dissipated by radiation at night, and would furnish a source of constant warmth.

BAD AIR AND BAD HEALTH.

By HAROLD WAGER and AUBERON HERBERT.

THE purpose of this paper is to utter a warning against the careless way in which the great mass of people, poor and rich, ignorant and learned, allow the air of their living-rooms to be in an impure condition, and to point out the great sacrifice of energy and health which results from this carelessness. We shall try to show that there is strong ground for believing that not only a large part of the ever-increasing trouble of bronchial and lung affections, but also a very large part of that vague and subtle ill-health which troubles our modern lives in varying forms, is to be placed to the account of the impure air which we so habitually breathe.

As we wish to make the paper plain to every one, we shall occasionally go back to the A B C of certain matters involved. The air which we breathe is made up of two gases, one active, one indifferent. The active gas, oxygen, on which life depends, is in the proportion of about one fifth (twenty-one per cent) of the whole; the indifferent gas, nitrogen, which tempers and dilutes its active partner, is in the proportion of four fifths (seventy-nine per cent), and with these two gases is found a small quantity—varying according to the purity of the air—of carbonic acid, about three to four parts in 10,000 parts, or 0·04 per cent, and in addition a minute quantity of a peculiarly active form of oxygen,

called ozone, which is rarely found in the air of towns. Of this gas-mixture (which we call air) we breathe enormous quantities. Of it we breathe in the twenty-four hours, according to Prof. M. Foster, over 2,600 gallons, that is about 425 cubic feet; and as it returns from our lungs the proportions of the mixture are changed, the oxygen being reduced, and the carbonic acid increased.* But in all ordinary cases the quantity of oxygen in a room in which people are meeting is only slightly decreased, while the increase of the carbonic acid is not sufficient to cause bad effects. How, then, arises the mischief?

The truth is that, in taking air into the lungs and breathing it out again, we breathe out with it certain organic poisons. About the existence and presence of these poisons there can be no doubt, though very little is known about their nature. Of them Dr. Foster writes (page 552) that they may be formed in the lungs, or may be products of putrefactive decomposition allied to a class of poisons known as ptomaines, which are found in the system. Dr. A. Ransome (Health Lectures, 1875-'76, page 160) says:

> The aqueous vapor arising from the breath, and from the general surface of the body, contains a minute proportion of animal refuse matter, which has been proved, by actual experiment, to be a deadly poison. . . . It is this substance that gives the peculiar, close, unpleasant smell which is perceived on leaving the fresh air and entering a confined space occupied by human beings or other animals, . . . and air thus charged has been fully proved to be the great cause of scrofulous or tubercular diseases, and it is the home and nourisher of those subtle microscopic forms of life that have lately become so well known under the title of germs of disease, or microzyms. It is probably the source of a large part of that increase of mortality that seems inevitably to follow the crowding together of the inhabitants of towns.

Galton says (Our Homes, page 497): "This organic matter (given off from the lungs), on an average, may be estimated at thirty or forty grains a day for each adult"; † and both Dr. Carpenter and Sir Douglas Galton notice that if breath be passed through water (and then kept in a closed vessel at a high temperature), putrefaction is set up, and a very offensive smell is given off.‡

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* It must be remembered that the act of breathing consists in bringing the blood of the system in contact with air, through a delicate membrane in the lungs. Here an exchange takes place—oxygen being yielded up from the air to the blood, and carbonic acid from the blood to the air.

† We do not know on what exact grounds this calculation rests.

‡ Foster (p. 552) states that "when the expired air is condensed . . . the aqueous product is found to contain organic matter, which, from the presence of micro-organisms, . . . is very apt rapidly to putrefy." L. P. writes: "If a globe be filled with ice and taken into a close, badly ventilated room, the dew which forms outside is found to be contaminated with these organic impurities." L. T. writes: "It is more than likely that it is this animal poison which is the *direct* cause of typhus fever as that follows overcrowding with mathematical precision."

Now let us take the case of a person who sits in a closely shut up room, ten feet high, ten feet broad, and fifteen feet long, for five hours.* At the end of that time he is breathing air which contains 1·2 per cent less oxygen than it ought to contain, but, what is far more serious, he is breathing some air which has already passed through his lungs, and which is charged with this special poison. Here is the great secret of the fatal mischief. Nature has got rid of the poison, thrown it out of the system, but the perverse occupant of the room insists on thwarting Nature, and, by means of his closed doors and windows, breathes in again, it may be a second time or a third time, the poison that has once been safely got rid of. Say that in twenty-four hours 500 cubic feet have passed once through the lungs, then in six hours our friend will have vitiated one quarter of that quantity, or 125 cubic feet—i. e., one twelfth of the whole air in the room (1,500 cubic feet). If he still goes on sitting in his study, at the end of nine hours he will have vitiated 187·5 cubic feet, or one eighth of the whole; or, if he has been unfortunate enough to have a friend sitting with him, then in six hours they will have tainted one sixth of the air; and of every mouthful of air they breathe after that time, one sixth of it must be supposed to be charged with poisons that have been already once got rid of, but are now being retaken into the system. Of course, this proportion of one sixth will not remain constant. Each breath expired will make the matter worse.

A few words seem necessary here for those who have never followed the changes going on in the body. We know that we are constantly building up new tissue of different kinds, and that this building up makes it necessary that the old tissue should be got rid of. The larger part of our food measures this change which is going on. If we take our daily food, liquid and solid, for twenty-four hours, as weighing about five pounds eight ounces (Hermann, page 233)—a large proportion being water—we may look upon about five pounds three ounces of this quantity as used for the making of new tissue, the other five ounces forming what is spoken of as exhausted ferments, and which, passing along the alimentary canal, is eventually rejected. Now, all the suitable part of the food, after undergoing various changes, which are necessary to prepare it for its passage from dead food into living tissue, finds its way into the blood; and when by means of the larger blood-vessels it reaches the very minute blood-vessels, called capillaries, it pours a part of itself out through the per-

* A considerable quantity of air, however, is always entering through window frames, under doors, even through brick walls. On the other hand, we have made no allowance either for space occupied by furniture or for the (probably) tainted condition of the room.

meable walls of these minute vessels, bathing and feeding the whole surrounding tissue. Thus, as somebody has said, the whole of the new and living body is in solution in this wonderful food-stream of the blood, which, by a very subtle mechanism of nerves, distributes its good gifts in proportion to the needs of each separate part. But the blood is not simply a food-stream, it is also a sewage-stream, and it is as such that we are specially interested in it. Where no growth or storing of flesh material of any kind is taking place in the system, it is evident that that part of the daily food which is turned into tissue measures not only the daily construction that is taking place within us, but also the daily destruction or waste. In fact we—if we may so speak of the particles of which we are composed—are forever living and dying within ourselves—making a new self, and getting rid of an old self; and just as the new living body is in solution in the blood, so also is the old dead body, that has done its work and has to be got rid of. Now, of this dead body a large part has to escape through our lungs and through our skin.

About this process of waste very little is known. We know, while certain temporary forms of waste are found in muscle, such as kreatin (Gr. *kreas,* flesh), which, whether again made use of or not (M. Foster, page 154), is supposed to be eventually changed in some complex manner into urea in the liver (M. Foster, page 755), and an acid called sarcolactic (Gr. *sarx*, flesh; *gala,* milk), which is also supposed to be decomposed in the liver into carbonic acid and water (M. Foster, page 826), that all our dead tissue is, with a certain slight but most important exception, got rid of safely at last, as urea, carbonic acid, and water.* These are the final forms which the waste that passes from the tissue into the blood takes—the urea being separated from the blood and got rid of by the kidneys, the carbonic acid both by the skin and the lungs, and the water by all three channels of separation.†

But we said that urea, carbonic acid, and water did not account for quite all the waste tissue; and among the part not so accounted for are the very hurtful poisons which escape from lungs and skin. What are these poisons? Have they a connection with or a resemblance to the poisons which, as we know, exist at all times within the system on a large scale. Dead or waste tissue probably passes through many forms before it reaches the safe final forms of carbonic acid and water, and we must conclude

* We are not taking into account certain other substances discharged from the skin in small quantities.

† "The natural waste of the body appears in two simple forms of carbonic acid—the gaseous form having the chemical formula CO,O, while that which is got rid of in solution is urea, that is, $CO,(NH_2)^2$, in which the second atom of oxygen in the carbonic acid is replaced by a nitrogenous body termed amidogen."—(L. P.)

that some of these forms are highly poisonous. We see this by what happens to a man when he is drowned. A drowned man is in reality a poisoned man. The waste which is going on everywhere and at every moment in his tissues is producing a poison of so deadly a character that when it can not be oxidized by receiving oxygen from the blood (as it does under ordinary circumstances by means of the two gallons (nearly) of air he breathes in a minute) death ensues in a few minutes. In this case the poison produced all over the system has been no longer rendered harmless by oxygen, and goes as poison to the brain. Now, this poisoning does not appear to be primarily or necessarily due to an excess of carbonic acid, which also accumulates in the blood when a man is drowned. As Dr. Foster shows, even where carbonic acid is got rid of and no oxygen available the same result follows. Thus we have a pretty clear indication that the poisoning which results is the non-oxidization of certain active poisons. Other indications point to the same conclusion. When a man faints from loss of blood he probably faints because the diminished stream of blood does not carry a sufficient quantity of oxygen with it to neutralize the poisons which reach the brain.* It is also noticeable that in both these cases convulsions occur—that is, oxygen being denied, the poisons (which retain all their virulence, from being non-oxidized) act as a very powerful stimulant on a part of the nervous center, which, in turn acting through the nerves, throws one set of muscles after another (connected with the respiratory system) into action, in order to obtain the oxygen that is absent; ending at last in that general violent movement which is called convulsions. After a short time the poisons overpower the nerve-centers and death ensues.†

Both fevers and violent exercise seem also to illustrate the same thing. In fever the tissue rapidly wastes, and great quantities of waste poison are poured into the blood. These poisons affect the nerves, and are the cause of quickened respiration, and often of quickened circulation,‡ which are necessary in order to

* One of the writers was informed by a friend in Africa that he was present when a man cut himself badly with a bill-hook and was carried into a cabin. Each time the door was closed the man fainted; each time the door was thrown open he came back to his senses, indicating pretty clearly that the supply of oxygen, which was unduly diminished by the loss of blood, was increased when the door was open, and was just sufficient to neutralize the effect of the waste poisons and prevent unconsciousness.

† It is interesting to remark here that this reaction of the nerve-center under the effect of the poison seems to be of that "protective character" which occurs so often, and to which Prof. Foster more than once has referred—that is to say, that it produces a violent movement of the muscles in the effort to obtain air, which can alone neutralize the mischief.

‡ In certain cases, however, the heart and circulation are slowed, not quickened. This is the case, Dr. Foster says, in drowning after a slight quickening has taken place. May

get the excess of poison oxidized; when, therefore, unconsciousness supervenes, we may say pretty confidently that the rapid circulation and the rapid breathing have not been sufficient to oxidize and neutralize the mass of poison which is being carried to the brain.* So, again, in pneumonia the quickened breathing shows both the effort of Nature to make up for the loss of that part of the lung which is ineffective, and also the stimulus which the increased waste poison in the blood (increased owing to diminished lung capacity, and therefore diminished oxygen) exerts upon the respiratory machinery. So, again, when less blood is carried to the lungs, owing to the artery which leads from the heart to the lungs being partially blocked with a clot, the same effect is produced. Probably a somewhat similar condition arises after hard work, either in old age or in a feeble state of health. The tissue, not being in the firm condition of the tissue of a vigorous person accustomed to daily work, breaks down in large quantities, while at the same time the circulatory and respiratory machineries are no longer at their best, and therefore the oxidation is imperfect. On the next day the infirm man is poisoned by the unusual quantity of waste in the system, and feels discomfort in many parts of his body or limbs. So, also, the discomfort acutely felt by some persons during east winds probably arises from the poison that ought to have been got rid of by the skin, but, owing to the closing of the pores, has been thrown back into the system. So also with ordinary violent exercise. When we take violent exercise an unusual quantity of waste is thrown into the blood, requiring an unusual quantity of oxidation. Here also the waste stimulates the nerve-centers, increasing action of heart, and of respiratory muscles, so that the blood charged with waste and the air may come into quicker contact. The successful ath-

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this not be explained by the supposition that, where oxygen is altogether denied, an increase in the rapidity of the circulation would carry the poison quicker to the brain, and therefore hasten the end? A different effect seems to occur in the case of vitiated air. In this case Müller asserts (as quoted by Mr. Angell, Manchester Health Lectures, p. 33, 1879–'80) that the circulation is slowed. Is this—if correctly stated—a consequence of the depressing action of these peculiar poisons, which escape with the breath, and are rebreathed in vitiated air? The case of flies which died in foul air with unexhausted tissue, alluded to later on, and some other evidence, seem to point in this direction. In exercise, on the other hand, the effect is, as one would expect, different: both respiration and circulation are quickened in order to increase the supply of oxygen required to meet the large increase of waste; thus it would appear as if the ordinary waste poisons stimulated, while the special poisons of vitiated air depressed. The whole subject calls for very careful consideration. A friend remarks that Dr. Burdon Sanderson, of Oxford, has long been and is working out these questions.

* This indicates very clearly that the purest and freshest air should flow through the room of a person suffering from fever. It would be almost as necessary to him as to the person suffering from loss of blood. Such treatment is confirmed by experience (see case of Austrian army, further on).

lete is, therefore, first the good oxidizer (see M. Foster, page 628), the person who has good lung capacity, and especially a powerful heart to drive the blood swiftly; and, secondly, the person who trains well, whose tissue is healthy and firm and does not break down rapidly into waste—waste in his case not outstripping the powers of oxidation, and thus causing distress. On the other hand, the untrained man, who breaks down in the race with every symptom of distress, is the poisoned man—the man who formed waste quicker than he could oxidize it.*

Reviewing, then, what we have said, we seem to see three things: first, that so long as we have a sufficiency of oxygen, we get rid of a large amount of daily waste in safe and harmless forms; secondly, that when oxygen is withheld from us there are poisons in every part of our tissue of so deadly a character (either abnormally formed because oxygen is absent, or under ordinary circumstances neutralized by the supplies of oxygen present) as to take life in a few minutes; thirdly, that even when all is well, and our system is functioning under healthy conditions, we are still always breathing out from ourselves, through lung and through skin, certain dangerous poisons, which poisons, when we are living in bad air, we perpetually reabsorb into ourselves, to our own great hurt.

Nothing, however, that we have said satisfactorily explains the presence of these poisons which escape from the lungs and the skin. It seems hard to explain why, when Nature so successfully

* In such a case it may be asked, Why are not the waste poisons passing into the blood from the tissues safely got rid of in the form of carbonic acid and water when the blood reaches the lungs? It seems difficult to escape from the conclusion (see Foster, p. 603) that these unoxidized waste products may, on occasion, pass the lungs without being got rid of. In the case of violent exercise, it would seem that the quickened heart and quickened breathing must come from the action of waste poisons, which, passing the lungs, reach the medulla and stimulate the nerve-centers, there not having been time, owing to the excessive quantity of waste produced, to reduce all the waste to the safe final products of water and carbonic acid, and therefore some part of the waste in an unoxidized state being carried past the lungs on to the nerve-centers. As regards the poisons we rebreathe from the air, it is, of course, rather a surprising thing, if they entered the circulation, that they should not be oxidized in the blood when we think of how they must be surrounded by the oxygen that the blood has received from the air. But active as oxygen is—in its "nascent" state, just released from hæmoglobin—in the tissues after leaving the blood, there are reasons for thinking that this activity does not exist in the blood itself. Thus we are told that pyrogallic acid, which is an easily oxidizable substance, may pass through the blood without undergoing any change; and fresh blood, as we are told, has little oxidizing effect. This strange powerlessness of the oxygen in the blood increases the danger of these waste poisons. If they were oxidized in the blood we should be able probably to get rid of them quite harmlessly, as they would not be in the condition of poisons when they escaped from lungs and skin; but we may feel sure that there is some good reason why this can not take place. When they are once carried to the tissues, except in the case of persons taking plenty of exercise and leading a healthy life, there may be no superabundance of oxygen, but rather a deficiency, for all the work to be done.

breaks down the great mass of waste into harmless products, there should be this comparatively slight residue left over—reminding one of a lawless fraction of people in an orderly state—which can not be got rid of on the same easy terms. As we have seen, we have about five pounds three ounces of daily waste that is safely got rid of as urea, carbonic acid, and water, by means of kidneys, skin, and lungs; but accompanying this safe discharge we have a few grains of poison—a sort of surplus of evil—which in some way or other seems to resist the oxidation to which all the other mass of waste has been subject. What, then, is this poison? How far is it the same, how far does it differ from the normal poisons of the tissues, which, as we see, in a few minutes destroy life when oxygen is withheld? Where and how is it formed? Are we to look upon it as a putrefactive poison formed at the surface of the lungs and the skin, when waste of some kind is escaping through these channels? Dr. Klein tells us (pages 61 and 241) that septic bacteria* (the authors of putrefactive change) are to be found in those parts of the body into which air penetrates, as the mouth, the air-passages, the whole alimentary tract; but it seems difficult not to believe, whatever changes take place as these poisons reach the air, that they must at all events have existed as chemical poisons when still in the tissues. Are we, then, to look upon these poisons as derived from putrefactive decompositions taking place in certain parts of the body; or as poisons derived from the tissues; or as in turn possessing both characters? At present, both within and without the body, their nature is surrounded with mystery, and many are the interesting questions that remain to be solved about them. When they have passed outside the body, are they the food of any of the bacteria which are found so plentifully in foul air?† If so, are the ordinary bacteria (excluding the case of certain bacteria producing disease) our friends or our enemies; do they render the poison itself harmless; or do they themselves produce an excretion which is of a poisonous character; or should they be looked on as neutral, destroying one poison and producing another; are the poisons themselves simply removed by currents of air, or are they oxidized in the air; if so, are they oxidized only when ozone is present (see Our Homes, page 11); and if in the air, why not in the blood, after we have rebreathed them and surrounded them with oxygen, in loose combination with hæmoglobin?‡

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* For a different view, see De Bary on Bacteria, p. 44.

† *Bacteria* (Gr. *bakterion*, a staff) are the smallest living organisms known, and generally included in the vegetable kingdom. They possess a very simple structure, are capable of free movement, and multiply very rapidly. Some kinds are the causes of putrefaction and of certain diseases. It is calculated that we inhale 300,000 germs of these organisms in the day.

‡ Mr. Wager adds the following note: "The bacteria on the surface are constantly at

Another light is thrown upon the waste poisons of the tissues by the statement that they exhaust the power of muscle to contract. Muscle taken from a freshly killed animal, if fed with arterial blood, or blood supplied with oxygen, may retain for some time its power of contraction. But if venous blood (blood that has lost its oxygen and is charged with waste poisons) be injected into it, the power of contraction is lost quicker than if no blood be supplied to it. In the same way the power of the muscle is soon exhausted if a solution containing substances which can be extracted from muscle (such as kreatin, lactic acid, etc.) be injected into it (M. Foster, page 150). These facts help us to see the local mischief which must often arise from these poisons, as well as their effects on the nerve-centers. Many an ache and pain are probably due to local effects of the waste poisons, whether they are the normal waste poisons of the system, which under unhealthy conditions of life we are not properly getting rid of, or the special waste poisons of skin and lungs that we have rebreathed into the system.*

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work excreting. At every breath we give off a small quantity of poison, whether we are breathing in pure or bad air. The quantity given off is extremely (extraordinarily) small—so small that it can only be approximately measured by the amount of carbonic acid in the air. These bacteria are present whether we live in foul air or pure air. Their existence there means that they can thrive, and if they thrive they must feed, and if they feed, they must excrete, or something analogous to it. Personally, I am inclined to think they (these special lung and skin poisons) come from the blood, because ptomaines can be formed by the action of various chemical agents (such as acids) upon protoplasmic or albuminous material, and as blood (serum) is albuminous, and as it contains various substances derived from tissue waste—e. g., lactic acid, uric acid probably, etc.—it may be that the two react upon one another, producing these ptomaine-like poisons. I think, however, that it is just possible that they may be formed on the surface.

* Where Nature does not get fair play, where, for example, the blood is vitiated by our constantly rebreathing poisons that have been already got rid of, other dangers probably exist. In the delicate chemical translations which take place when tissue is being changed into harmless waste, it may happen that the process goes wrong, and an abnormal poison is formed. Thus, under certain circumstances, instead of urea, uric acid is formed; thus in uræmia, or retention of urea in the system, various secondary compounds are formed (Carpenter, p. 448), which act on brain or spinal cord as narcotic poisons; thus, in acute yellow atrophy, where liver-cells lose a part of their activity, a substance called leucin is manufactured to a considerable extent instead of urea (M. Foster, p. 755); thus gall-stones are formed instead of gall, and certain changes take place in the bile, by which some of its constituents cease to be dissolved in it (M. Foster, p. 431); thus the ptomaines—a class of mysterious poisons—are formed in the system (Quain, Ptomaine, p. 1816) after various illnesses. [In connection with these ptomaines a dispute arose during an Italian trial as to whether a poison detected in a body was strychnine, or this naturally formed ptomaine.] Thus, too, Blythe (Poisons, A. W. Blythe, pp. 468–470) describes cases in which narcotic poisons have been formed by synthesis of substances in the tissue or in the blood. So also we might quote the interesting speculation of Dr. Carpenter (p. 368), that a cancer is an excretory organ, formed to get rid of poisons in the system, illustrating once more "the protective nature" even of that which brings pain and death; and the case of certain pathogenic organisms, which, as Dr. Klein suggests (p. 248), may not affect healthy living

We now pass to other evidence affecting the poison that escapes from lungs and skin. We all know that a room is offensive when many people are crowded into it; we know the unpleasantness of a bedroom before the air has freely entered it; we know how disagreeable the breath and the clothes can be; we know that animals die when submitted to air that has been breathed, even when the carbonic acid has been removed;* we know how necessary is the continuous flood of pure air in hospitals—we have heard it stated that this much freer admission of air is rendering unnecessary the antiseptic treatment of wounds; how by treating men in the open air and in tents recoveries have been made quicker and better than in hospital;† and how in the case of the Austrian army "the most severe maladies ran their course much more mildly" in the free air, while the recovery was quicker and more perfect (Ransome, Health Lectures, 1875–'78, page 151). So also Dr. Parkes says (page 181) in cases of blood-poisoning, the best treatment is complete exposure to open air; so also in typhus; and in a less degree in enteric fever, small-pox, and plague. "This complete exposure," he adds, "of patients to air is the most important mode of treatment, before even diet and medicines."‡ In

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tissues, but only diseased tissues—the disease implying alteration of the tissue. All these cases are cases, doubtless, of an extreme kind; they imply the abnormal formation of poisons to a serious extent, sufficient to constitute illness; but it may well be that there are many less serious formations of abnormal poisons, which, though not sufficient to produce illness, yet cause much discomfort, and which are the consequence of the vitiated state of the blood, arising from the habitual breathing of impure air.

* If we remember rightly, both Parkes and D. Galton (Our Homes) refer to these experiments—a mouse dying in forty-five minutes when submitted to air treated in this manner. Dr. Richardson also refers in one of his works to experiments, which were conducted by himself, and which are more fully described in a report to the British Association. Dr. Richardson had formerly a theory of "devitalized oxygen," but we suppose he would probably consider now that it was a truer statement to say that this special poison had not been removed from the air which the creatures breathed. Experiments of the same kind have also been made on rabbits in Paris. One of our number (A. H.) adds the following remark: "Though I think probably it would be quite misleading to speak of the experiments upon the mouse, and the experiments conducted by Dr. Richardson as in any sense cruel, yet, speaking my own personal opinion, I remain opposed to all such experiments. While I admit the neat and convenient evidence often supplied by them, and also admit that difficulties of method would at first exist, were they renounced, yet I think the wealth of materials that exist on all sides of us for pushing forward knowledge is so vast, that however convenient these experiments may be, they are not really necessary, while perhaps a keener perceptive sense in tracing out the meaning of the things of common life, which are of such vital importance, would be developed, as investigators renounced this particular method. In writing this, however, I am governed by the moral side of the question, which is the one that, apart from all other considerations, determines my view."

† The case of the hospital is, of course, a complicated case, and it might be disputed how far its evidence can be used for our purpose.

‡ "When our health commissioners were sent out to the Crimea to examine the heavy mortality among soldiers in the hospitals, their first act was to use their sticks to break

the same way, the deaths of the Black Hole of Calcutta add their evidence, though it is an evidence of an extreme kind. While out of the one hundred and forty-six persons shut up, one hundred and twenty-three died, of the remaining number (Carpenter, page 357) many afterward died of putrid fever—that is, were poisoned, owing to an insufficiency of oxygen to neutralize the poisons breathed out on all sides of them, and rebreathed by themselves. A much simpler piece of evidence is presented to us daily by our own eyes. Who is not struck by the pasty, anæmic look of our city children, and of the large number of those who follow sedentary occupations, as contrasted with the looks of those who live in the country and are much in the open air? What is that pasty, anæmic look? It is the absence of red corpuscles from the blood, indicating that where oxygen is deficient * the red corpuscles are not produced in their proper quantity. So also the effects of living in rooms in which sewer-gas has penetrated illustrate in their own stronger degree the effects of living in unventilated rooms. The one is the lesser form, the other the more serious form of the same evil. In both, bacteria thrive and multiply, and in both, meat and milk rapidly taint. They are both full of organic matter, and the symptoms of headache and feverishness are common to both, though, of course, the case of sewer-gas is much the more acute case. † Again, we all know the wonderfully restoring effect that hill air with its ozone has upon us after town life; showing how the poison has depressed all our functions, and how the pure air restores their energy. We see the same effect in the lives of work-people. Sir D. Galton, as we have seen, tells us of better work done, more energy, more appetite, when air is introduced into unhealthy work-rooms. Dr. Parkes tells the same story. Dr. A. Ransome, speaking in 1875, quotes the case of the Guards, picked men, highly cared for, yet who died quite as fast as the civil population. Why? he asks. Mainly from defective ventilation of the barracks (Health Lectures, 1875–'78, page 150).‡

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some hundreds of glass panes in the windows, so as to admit air freely. After that the wounded recovered rapidly."—(L. P.) In the same way Dr. Clifford Allbutt reduced the mortality in a heavy epidemic of typhus fever in Leeds by fastening the windows in the fever hospital with screws, so that they could not be shut. He remarks that in Ireland those attacked with typhus, who were put out to die, would often recover.

* But why is oxygen deficient in these cases? Is it, once more, because so much organic poison is breathed in with the air of the shut-up rooms, that the functions are depressed and imperfectly performed; that, for example, the act of respiration is impaired? Or does the poison directly affect the formation of the red corpuscles?

† It has, however, been shown recently that the air in a well-ventilated sewer is, so far as organic matter and micro-organisms are concerned, purer than the air in a small, badly ventilated room.

‡ "Sir Lyon Playfair, one of the commissioners for inquiring into the state of barracks, passed a couple of nights with the soldiers in their crowded sleeping-rooms, and found the

Again, we find disease attacking country districts for the first time, where houses had been improved, and the ventilation, which used to take place through porous walls and less well-fitting windows, has been done away with.* So also it is stated by Mr. Angell (Health Lectures, 1879–'80, page 31) that in the old crowded lodging-houses people sleeping on the floor would escape fever, while those sleeping on the bedsteads would be struck by it. Those on the floor got ventilation from the door and fireplace; those on the bedsteads were above the line of it—the colder

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air saturated with organic effluvia which discolored permanganate of potash. The mortality among soldiers is now greatly reduced by the better ventilation enforced by the commission."—(L. P.)

* A case of this kind is reported to us by Mr. Alexander Campbell, of Auchindarroch, Lochgilphead; and we believe that the same thing was observed in a Westmoreland district. In an interesting letter Mr. Campbell writes: "Some years back I was asked by a medical officer of large experience in the Highlands regarding a phenomenon which had puzzled him. He had exerted himself much, and with great success, to have improved cottages built, but in proportion as the cottages grew better did the health of the people grow worse. I gave him my opinion that in the old, uncomfortable-looking cottages, built may be of dry stone, and open to the roof, the people were kept healthy in spite of themselves by the wind blowing through them, while the new cottages, tightly built, and with well-fitting doors and windows, excluded the air, and the windows being seldom or never opened, the inhabitants were poisoned. He said he fully agreed in this, and would ask for no more new cottages until the people had learned how to live in them. I have found a considerable amount of ill health among the paupers in the island of Tiree, which, from its situation, exposed as it is to the free action of breezes from the Atlantic, should be one of the healthiest islands of the Hebrides. I attribute this to the mode in which the houses are built, with two walls two or three feet apart, the interval being closely packed with sand. The air is thus hermetically excluded, and unless the windows are made to open, and are freely opened, the inhabitants are constantly, when within their dwellings, breathing vitiated air." It is also worth while quoting from a review of Major Fisher's book (which book we have not read) in The Spectator, May 2, 1891, Through the Stable and Saddle Room: "Everybody knows something of the importance of ventilation, both for man and horse; but it is not so widely known as it ought to be that, while horses seldom or never take cold through being exposed to cold, they are often made ill by being too warm. [It is not the warmth; it is the impure air.] It is the inside, not the outside, air that gives them coughs, sore throats, congestion of the lungs, and sundry other ills to which horse-flesh is heir. For this reason, old ramshackle stables, full of cracks and crevices, are healthier than brand-new buildings with tight doors and windows and impervious roofs. Our author, who never generalizes rashly, and supports his theories with copious instances, mentions one or two curious 'cases in point.' Remounts for cavalry regiments, which are mostly of Irish extraction, have often to travel in severe weather part of the way in cattle-trucks, with no other protection from the cold than their own coats. Nevertheless, the remounts nearly always arrive at their destination in perfect health; yet they are no sooner placed in stables, however well ventilated, than they begin to suffer from coughs and colds, which generally end in strangles. During the autumn manœuvres of 1875, Major Fisher's regiment was encamped near Aldershot, and though it rained almost incessantly, and the horses were picketed in the open, without so much as a blanket to cover them, colds and coughs were unheard of, and the favorite charger of one of his brother officers, which at the time she left the barrack-stable suffered from a severe cold, was made whole by a few days' exposure to the elemental strife." The book should contain some valuable facts.

and purer air being heavier than the heated impure air, and therefore nearer the line of the floor.

Animals furnish the same evidence. Cows and horses both suffer grievously from want of ventilation in their stables; and cattle, though they require warmth for fattening, still put on flesh better in a colder but well-ventilated place than in a warmer place which is unventilated (Parkes, page 180). So also Parkes tells us about the French cavalry. Before 1836 the mortality among the horses varied from 180 to 197 per 1,000 per annum. With the enlargement of the stables and increased quantity of air, the loss was reduced to 68 per 1,000, and finally to 28½ per 1,000, and of officers' horses to 20.

Then we have the evidence of the ordinary tests for ascertaining the purity of the air. Air fouled by respiration discolors permanganate of potash and robs it of a portion of its oxygen; the amount of organic matter is then measured by the number of volumes of oxygen required to reoxidize the permanganate and restore it to its former condition. Another test is the presence of certain bacteria, which are found in large numbers in foul air, increasing out of proportion to the molds or fungi found in the air, which appear to be much less affected by impurities. It is stated that these forms of life all originally come from the open air—that reservoir of all things—though they are supposed to multiply in congenial quarters when once they have found an entrance. The significant fact, however, is their number, which might seem to show that they prosper just because they have discovered their proper food—the organic poison which is poured out into the air from our lungs and skin. On this point, Dr. A. Ransome makes an interesting speculation, which we quote from memory—a wrong thing to do. Impressed with the belief that consumption is communicable in foul air, and non-communicable in good air, he believes that the bacillus (a form of bacteria) which conveys the disease retains its virulence more in foul air than in pure air, and is thus better able to make a lodgment in the human system.*—*Contemporary Review*.

[*To be concluded.*]

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* This speculation of Dr. A. Ransome's suggests another speculation. Dr. Klein (pp. 238–248) believes that in the interior of healthy human tissue no bacteria, which cause putrefaction, are found. They are found abundantly in those parts of the system to which air penetrates, as, for instance, in the mouth, or in the alimentary canal; and from the alimentary canal they pass easily, as the food itself does, into the diminutive blood-vessels or the diminutive lymphatics (locally called lacteals) that line the walls of this canal. But if the blood is in healthy order they seem to perish, dying for want of food. Dr. Klein goes on to state that if at some point they are carried to tissue that is in an unhealthy condition, there they may obtain a footing and begin to multiply. He does not actually state, as we understand, that the unhealthy condition of the blood keeps them alive, but he implies it; and it would seem probable that the unhealthy state of the blood—for ex-

SKETCH OF JOHN AND WILLIAM BARTRAM.

During the century which preceded the American Revolution the science of the colonies, like their commerce, was tributary to that of the Old World. Fabulous reports in regard to the natural resources of America had been brought home by European voyagers, and the cultivators of all sciences and arts were looking to that vast unexplored region for products which should increase the knowledge of the naturalist, the resources of the physician and the agriculturist, the profits of the merchant, and the enjoyment of the man of leisure. The function of those colonists who inclined to natural history was that of explorers and collectors, and among the earliest and most notable of these American collectors were the subjects of this sketch.

The grandfather of the elder Bartram, also named John, came from Derbyshire, England, to Pennsylvania in 1682. He brought his wife, three sons, and one daughter, and settled near Darby, in Delaware (then Chester) County. The third son, William, was the only one who married, his wife being Elizabeth, daughter of James Hunt. Both families belonged to the Society of Friends. The children of William were John (the botanist), James, William, and a daughter who died young. The second William went to North Carolina and settled near Cape Fear; John and James remained in Pennsylvania.

The date of John Bartram's birth was March 23, 1699. But little is on record concerning his early years. Like the majority

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ample, blood charged with poison which have escaped from the skin and lungs, and been rebreathed into the system—would have the same favoring effect upon them as the unhealthy tissue. Both are likely to present them with the food they require. If this be so, then just as the bacteria that cause disease are favored by the external poisons they find in vitiated air, so also they may be internally favored by the unhealthy state of the bronchial and lung tissues of those persons who habitually breathe the poisons of shut-up rooms. Thus, these organic poisons, both within and without a man, would tend to make him a prey to those illnesses in which the success of the germ depended upon its proper—might we say—food being supplied to it; and it would seem probable that, by constant attention to the purity of the air which we breathe, we might do much toward securing individual exemption from the danger of infectious diseases. An instructive passage in Dr. Carpenter (p. 365) which bears on this point should be read. It is also worth quoting Prof. Nussbaum (see an interesting article by Mrs. Priestley, May, Nineteenth Century, p. 825): "It is known with certainty that the cholera bacillus is dangerous only to those persons whose stomach is not in a healthy state, and jeopardizes life only when it passes into the intestines. A healthy stomach will digest the bacillus, and therefore it does not reach the intestines in a living state." It is, perhaps, right to refer here to a theory that in the blood and connective and lymphatic tissues (Klein, p. 243) there exists a clan of protective cells (phagocytes), whose office it is to overpower invading bacteria of a dangerous character; and, according to Metschnikoff (Ann. de l'Institut Pasteur) these can, in case of need, emigrate to any part of the body which is invaded by parasites.

of boys in the colonies, he was brought up to a farming life, and his education was only such as the country schools of the time afforded. After reaching adult years he studied Latin a little, so as to be able to pick out the descriptions of plants in the Latin works of European botanists. In a sketch of John Bartram, written by his son William, it is stated that he had an inclination to the study of physic and surgery and did much toward relieving the ailments of his poor neighbors. In January, 1723, he married Mary, daughter of Richard Morris, of Chester Meeting, by whom he had two sons—Richard, who died young, and Isaac, who lived to old age. His wife Mary died in 1727, and in September, 1729, he married Ann Mendenhall, of Concord Meeting, who survived him. John and Ann Bartram had nine children, five boys and four girls. Of these the third son was William, he and his twin

Bartram's House in 1887. (From a photograph furnished by Mr. Thomas Meehan.)

sister, Elizabeth, being born February 9, 1739. The ground on which John Bartram laid out the first botanic garden in America was on the west bank of the Schuylkill River, at Kingsessing, near Gray's Ferry (now within the city limits of Philadelphia), and was bought by him September 30, 1728. "Here he built with his own hands," says William, "a large and comfortable house of hewn stone, and laid out a garden containing about five acres." A view of this house, which is still standing, is given in the

accompanying picture. The year of its erection is shown by a stone in the wall on which is cut "JOHN * ANN BARTRAM, 1731." Another inscription on a stone over the front window of his study reads:

"'Tis God alone, Almighty Lord,
The Holy One, by me adored.
"JOHN BARTRAM, 1770."

That the building was a labor of love is attested by the care bestowed upon the carved stone-work around the windows and doors and the pillar under the porch. John Bartram must have been a good stone-cutter and mason, for this was one of four stone houses that he built in his lifetime.

Nearly all the extant information concerning the lives of the two Bartrams has been embodied in the Memorial of John Bartram, by William Darlington, published in 1849. This volume contains the sketch of John Bartram by his son William, with some additions by the editor, and over four hundred pages of correspondence. About a fourth of these letters are from his friend Peter Collinson; the others are from eminent botanists in Europe and America, and from Bartram to these various correspondents. Darlington also reprinted a sketch of John Bartram, which appeared in the Letters from an American Farmer, by J. Hector St. John, published in London soon after Bartram's death. The "letter" describing Bartram purports to be written by a Russian traveler, who is evidently a myth, although in all important respects the account represents the botanist as he was. As to how Bartram's interest in botany was aroused, the "Russian gentleman" has a very pretty story, telling of a sudden conversion after the botanist had married; but Bartram himself is better authority, and he writes to Collinson, May 1, 1764, "I had always since ten years old a great inclination to plants, and knew all that I once observed by sight, though not their proper names, having no person nor books to instruct me."

He was encouraged to study systematically by James Logan (founder of the Loganian Library, in Philadelphia), who gave him several botanical works. In order that his explorations, begun at his own expense, might be extended, Bartram's friends prompted him to seek the patronage of some wealthy and influential person in the mother-country. Accordingly, a quantity of his specimens and a record of some of his observations were sent to Peter Collinson, a Quaker merchant in England, who was greatly interested in horticulture. Bartram's consignment secured his interest, and led to a correspondence, which lasted nearly fifty years. The first letter in Darlington's collection is from Collinson, under the date January 20, 1734–'35, and refers to letters from Bartram of the preceding November; hence this correspondence probably

began when Bartram was about thirty-five years of age. In his early letters Collinson makes many inquiries about American plants and requests for specimens. He sends Bartram seeds, roots, cuttings of trees, vegetables, and flowering plants cultivated in England, packages of paper in which to preserve specimens, and gives him directions for collecting and drying plants. From time to time he sends presents of cloth and other articles for the use of the botanist or his family. For Bartram's "improvement in the knowledge of plants" he early offers, if duplicate collections are sent, to "get them named by our most knowing botanists, and then return them again, which will improve thee more than books." In this way the learning of Dillenius, Gronovius, and other eminent men was brought to the aid of the humble colonist. Collinson obtained for Bartram many orders for seeds and roots of American plants, and early secured for him the patronage of Lord Petre, whose gardens and hot-houses were probably the most extensive in the kingdom. This noble amateur ordered quantities of seeds from time to time, and when Bartram asked for a yearly allowance to enable him to extend his explorations, Lord Petre agreed to contribute ten guineas toward it. As much more was obtained from the Duke of Richmond and Philip Miller, and the twenty guineas were paid each year till 1742, when Lord Petre died. The first expedition that Bartram made with this assistance was an exploration of the Schuylkill River. He transmitted his journal of the trip and a map of the river to his patrons, and with both of these Collinson reported Lord Petre to be much pleased.

Besides plants, Collinson asks Bartram at various times to send insects, birds, and their eggs and nests, terrapin and other turtles, snakes, shells, wasps' and hornets' nests, and fossils, which last were then regarded as "evidences of the Deluge." "My inclination and fondness to natural productions of all kinds," he writes, "is agreeable to the old proverb, '*Like the parson's barn—refuses nothing.*'" During the second year of his allowance Bartram complains that it does not recompense him for his labors, and he also finds fault with Collinson for giving him seeds and cuttings that he has already, and for not having answered some of his letters. Collinson, in a business-like reply, shows that Bartram's complaints are due to his ignorance of commercial affairs and the difficulty of transatlantic communication, and to his exceeding the commissions of his patrons—whereupon the botanist promptly apologizes.

In 1738 Bartram made a journey of five weeks through Maryland and Virginia to Williamsburg, then up the James River, and over the Blue Ridge Mountains, traveling in all about eleven hundred miles. Most of the botanist's expeditions were made

without any scientific companion. "Our Americans," he writes to a correspondent, "have very little taste for these amusements. I can't find one that will bear the fatigue to accompany me in my peregrinations."

In an undated letter, written probably in 1739, to Colonel Byrd, of Virginia, Bartram reports that he had been making "microscopical observations upon the male and female parts in vegetables." He had also made, he says, "several successful experiments of joining several species of the same genus, whereby I have obtained curious mixed colors in flowers, never known before." To this he adds: "I hope by these practical observations to open a gate into a very large field of experimental knowledge, which, if judiciously improved, may be a considerable addition to the beauty of the florist's garden." It was in this "field of experimental knowledge"—namely, cross-fertilization—that Darwin afterward won a share of his fame. Bartram evidently discussed this subject with Collinson, for the latter writes in 1742: "That some variegations may be occasioned by insects is certain; but then these are only annual, and cease with the year." Permanent variegations, he says, are produced by budding—a sort of inoculation.

That Bartram had a hostility to superstition, tempered with much considerateness for persons, is shown by a letter in which he tells of a visit to Dr. Witt, of Germantown, another of Collinson's correspondents. He says: "When we are upon the topic of astrology, magic, and mystic divinity, I am apt to be a little troublesome, by inquiring into the foundation and reasonableness of these notions—which, thee knows, will not bear to be searched and examined into: though I handle these fancies with more tenderness with him than I should with many others that are so superstitiously inclined."

One of the botanists whose offices Collinson had secured in identifying Bartram's specimens was Prof. Dillenius, of Oxford, and in 1740 Collinson writes for some mosses for him, saying, "He defers completing his work till he sees what comes from thee, Clayton, and Dr. Mitchell." In the same year a list of specimens which had been named by Dr. J. F. Gronovius, of Leyden, was returned, and contained this entry: "*Cortusæ sive Verbasci*, Fl. Virg., pp. 74, 75. This being a new genus, may be called BARTRAMIA." The name Bartramia is now borne by a different plant—a moss growing in the Berkshire Hills of Massachusetts.

Bartram's correspondence with Gronovius began about 1743, and extends over a dozen years or more. Gronovius writes at length, very appreciatively, and makes many requests. He sends his books as they appear, and before the publication of his Index

Lapidæ, sends a transcript of the passage, in Latin, in which he is to give Bartram credit for his fossil finds.

Among the European scientists whom Collinson made acquainted with Bartram's work was Sir Hans Sloane, physician and naturalist, who succeeded Newton as President of the Royal Society. At his request Bartram sends him, in 1741, some "petrified representations of sea-shells." The next year Sloane sends to Bartram a silver cup inscribed:

"The gift of S^r Hans Sloane, Bart.
To his Fr^d John Bartram.
Anno 1742."

A figure of this cup is given by Darlington. Sloane also sent Bartram his Natural History of Jamaica, in two ponderous folio volumes.

About this time a correspondence began between Bartram and Dr. John Fothergill, a wealthy physician and naturalist, who, like Sloane, had first received some of Bartram's specimens from Collinson. Dr. Fothergill wishes to know what mineral springs there are in America, and Bartram sends him what information he has and can get from others.

Bartram also exchanged letters with Philip Miller, author of the Gardener's Dictionary, with George Edwards, who in 1766 sends his book, containing descriptions of birds that the Pennsylvanian had sent him, with Prof. John Hope, of Edinburgh, and with the ablest observers of nature in the colonies, among whom were Dr. John Mitchell, Rev. Jared Eliot, John Clayton, Cadwallader Colden, and Dr. Alexander Garden.

In 1744 he writes, "Dr. Gronovius hath sent me his Index Lapidæ, and Linnæus the second edition of his Characteres Plantarum, with a very loving letter desiring my correspondence, and to furnish him with some natural curiosities of our country." The same year he sends to England his Journal of the Five Nations and the Lake Ontario, describing a journey he had made the preceding fall. It contained an account of the "soil, productions, mountains, and lakes" of those parts of Pennsylvania and New York through which the route lay; and gave the proceedings of a great assembly of Indian chiefs held to treat with the agent of the Province of Pennsylvania, whom Bartram accompanied. This journal was afterward published in London.

The visit of Peter Kalm to America took place in 1748 to 1751. He traveled through Canada, New York, Pennsylvania, and adjoining provinces; made the acquaintance of the Gray's Ferry botanist, and obtained much assistance from him. It has been alleged that Kalm took to himself the credit of some discoveries which rightfully belonged to Bartram. This would not be suspected from reading Kalm's Travels, in which he gives Bartram

a page and a half of hearty commendation, saying among other things: "We owe to him the knowledge of many scarce plants, which he first found, and which were never known before. . . . I likewise owe him many things, for he possessed that great quality of communicating everything he knew. I shall, therefore, in the sequel frequently mention this gentleman." On nearly every one of the next twenty pages credit is given to Bartram for information.

In 1751 Benjamin Franklin and D. Hall published at Philadelphia an American edition of Dr. Thomas Short's Medicina Britannica, "with a Preface by Mr. John Bartram, Botanist, of Pennsylvania, and his Notes throughout the work; . . . and an Appendix, containing a description of a number of Plants peculiar to America, their uses, virtues, etc." The notes told where the plants were found in America, and how they differed from the English varieties.

John Bartram's son William begins to figure in his father's correspondence when about fifteen years old. At that time Bartram sent some of William's drawings of natural objects to Collinson, and took him on a trip to the Catskills. In 1755 Bartram writes: "I design to set Billy to draw all our turtles with remarks, as he has time, which is only on Seventh days in the afternoon, and First-day mornings; for he is constantly kept to school to learn Latin and French." This attention to the languages indicates that Bartram was determined that his son should not suffer from the lack that had limited his own reading of works on natural history. William was then attending the old college in Philadelphia.

The same passage shows also that Bartram's ideas about Sunday occupations were somewhat unusual for that generation, and in fact it is stated that he was excommunicated by his brother Quakers about this time for his independent religious views. The question of an occupation for William now came up, and in the letter just quoted his father asks Collinson's advice in the matter. "My son William," he writes, "is just turned of sixteen. It is now time to propose some way for him to get his living by. I don't want him to be what is commonly called a gentleman. I want to put him to some business by which he may, with care and industry, get a temperate, reasonable living. I am afraid that botany and drawing will not afford him one, and hard labor don't agree with him. I have designed several years to put him to a doctor, to learn physic and surgery; but that will take him from his drawing, which he takes particular delight in. Pray, my dear friend Peter, let me have thy opinion about it." Franklin offered to teach William the printing trade, but Bartram was not quite satisfied with the prospects for printers in Pennsylvania, and

Franklin then suggested engraving. But William became neither printer nor engraver. At the age of eighteen he was placed with a Philadelphia merchant, Mr. Child, where he remained about four years.

Bartram's science was largely practical. He wrote to Dr. Alexander Garden, of Charleston, in 1755, suggesting a series of borings on a large scale, to search for valuable mineral products. He gives as another reason the satisfaction to be derived from knowing the composition of the earth, and adds, "By this method we may compose a curious subterranean map." "This scheme of John Bartram's," says Darlington—"if original with him—would indicate that he had formed a pretty good notion of the nature and importance of a geological survey and map, more than half a century before such undertakings were attempted in our country, or even thought of by those whose province it was to authorize them."

Bartram was evidently much interested in geological subjects; thus, in 1756 he writes, "My dear worthy friend, thee can't bang me out of the notion that limestone and marble were originally mud, impregnated by a marine salt, which I take to be the original of all our terrestrial soils."

In 1760 he makes a trip through the Carolinas, his Journal of which he wrote out and sent to England. The following summer, William, then twenty-two years old, went to North Carolina and set up as a trader at Cape Fear, where his uncle William had settled when a young man. That year John Bartram makes a journey to Pittsburg and some way down the Ohio River, keeping a journal, as usual, which is sent to his English friends. Nearly all of these trips were made in autumn, so as to get ripe seeds of desirable trees and plants.

Bartram had too tender a feeling toward animal life to be much of a zoölogist. He says on this score: "As for the animals and insects, it is very few that I touch of choice, and most with uneasiness. Neither can I behold any of them, that have not done me a manifest injury, in their agonizing mortal pains without pity. I also am of opinion that the creatures commonly called brutes possess higher qualifications, and more exalted ideas, than our traditional mystery-mongers are willing to allow them." His ideas concerning animal psychology were thus clearly in advance of his time.

The war with France, known to Americans as the French and Indian War, resulted in extending the British possessions in America as far west as the Mississippi River. Immediately a desire was expressed in England for a thorough exploration of this great accession of territory. Bartram writes in 1763 that this could not be made without great danger from the Indians. His

own expeditions had been very short during the hostilities. The late war had shown the colonists what atrocities the savages were capable of, and the prevailing feelings toward the red men had become dread and hatred. "Many years past in our most peaceable times," writes Bartram, "far beyond the mountains, as I was walking in a path with an Indian guide, hired for two dollars, an Indian man met me and pulled off my hat in a great passion, and chawed it all round—I suppose to show me that they would eat me if I came in that country again." In two other letters he says that the only way to make peace with the Indians "is to bang them stoutly." The question arises whether the combative disposition of the botanist thus revealed might not have been one of the reasons for his exclusion from the Society of Friends.

In 1764 Bartram sends to England his Journal to Carolina and New River. In this year, one Young, of Pennsylvania, managed to gain the favor of the new king, George III, by sending him some American plants, and obtained sudden preferment. It was said that all the plants had been sent to England before—many of them by Bartram. The friends of our botanist, feeling that he was much more deserving of such favor, urged him to send some specimens to the king, which he does through Collinson, desiring that he may be given a commission for botanical exploration in the Floridas. April 9, 1765, Collinson writes, "My repeated solicitations have not been in vain," and reports that the king has appointed Bartram his botanist for the Floridas, with a salary of fifty pounds a year. This appointment continued till the death of the botanist, twelve years after. Bartram accordingly made an expedition in the South the next fall. He was then sixty-six years old; and, although his eagerness for exploring was undiminished, he felt the need of a companion on this trip, and got William to go with him, the latter closing out his not very successful business at Cape Fear in order to do so. In his sketch of his father, William states that he had been ordered to search for the sources of the river San Juan (St. John's), and that he ascended the river its whole length, nearly four hundred miles, by one bank, and descended by the other. He explored and made a survey of both the main stream and its branches and connected lakes, and made a draught showing widths, depths, and distances. He also noted the lay of the land, quality of the soil, the vegetable and animal productions, etc. His report was approved by the governor of the province, and was sent to the Board of Trade and Plantations in England, by which it was ordered published "for the benefit of the new colony." Bartram collected a fine lot of plants, fossils, and other curiosities on this trip, which were forwarded to the king, who was reported to be much pleased with them. His journal is still extant, in a volume with an Ac-

count of East Florida, by William Stork, published in England. It is evident from this production that the botanist was not a ready writer. His observations are minute and sagacious, and his language is simple, but his sentences are loosely strung out, and the record is the barest statement of facts. His Journal to the Five Nations, however, is much more readable.

William seems to have been much taken with Florida, and accordingly his father helped to establish him as an indigo-planter on the St. John's River. After about a year of disastrous experience he returned to his father's home and went to work on a farm in the vicinity. Collinson had been watching for an opening for William in England, but so far nothing had come of it. The next year he writes that the Duchess of Portland, a "great *virtuoso* in shells and all marine productions," had just dined at his house, and, having seen William's drawings," she desires to bestow twenty guineas on his performances *for a trial.*" The kind of objects she wants drawn are told. The same month, July 18, 1768, Collinson writes to William that he had also secured an order from Dr. Fothergill for drawings of shells, turtles, terrapin, etc. This was probably the last letter of Collinson to the Bartrams, as he died on the 11th of the following month. During his long friendship with John Bartram the two men had never seen each other.

William now began to send drawings and descriptions to Dr. Fothergill from time to time. In 1772 he began explorations in the Floridas, Carolina, and Georgia, the expense of which for nearly five years was borne by Dr. Fothergill, and to him William's collections and drawings were turned over. William made many contributions to the natural history of the country through which he traveled, and in 1791 published his Travels through North and South Carolina, Georgia, East and West Florida, together with an account of the Creek, Cherokee, Choctaw, and other tribes of Indians which he visited. His attitude toward the red men is much more favorable than that of his father. The volume contains many engravings of plants and birds from the author's own drawings. Of this book Coleridge said: "The latest book of travels I know written in the spirit of the old travelers is Bartram's account of his tour in the Floridas. It is a work of high merit every way."

Among the influential friends of the elder Bartram was Benjamin Franklin. While in England Franklin writes to him and sends him seeds of garden vegetables at various times; and when the Revolution had stopped his sending seeds to England, Franklin offers to sell them for him in France.

Among the testimonials to his botanical achievements that Bartram received was a gold medal, weighing 487 grains, from

a society in Edinburgh, founded in 1764, for obtaining seeds of useful trees and shrubs from other countries. This medal is inscribed, "To Mr. John Bartram, from a Society of Gentlemen at Edinburgh, 1772"; and on the reverse, "MERENTI," in a wreath. The medal is figured in Darlington's Memorials, and when that book was published was in the possession of a Mrs. Jones, a descendant of the botanist. April 26, 1769, the Royal Academy of Sciences, of Stockholm, on the proposal of Prof. Bergius, elected Bartram to membership. Another honor that he received from the same country was a letter from Queen Ulrica, and with this may be mentioned the opinion passed upon him by Linnæus, who called Bartram the greatest natural botanist in the world. Bartram was one of the original members of the American Philosophical Society, and contributed many papers to its Transactions.

The closing years of John Bartram's life were the opening years of the Revolution. He was living when independence was declared in the neighboring city of Philadelphia, but died the following year, September 22, 1777, at the age of seventy-eight. A granddaughter, who remembered him distinctly, has stated that he was exceedingly agitated by the approach of the British army after the battle of Brandywine, and that his days were probably shortened in consequence. The royal troops had been ravaging the country, and he was apprehensive lest they should lay waste his darling garden.

His son William describes him as "a man of modest and gentle manners, frank, cheerful, and of great good nature; a lover of justice, truth, and charity. . . . During the whole course of his life there was not a single instance of his engaging in a litigious contest with any of his neighbors or others. He zealously testified against slavery, and, that his philanthropic precepts on this subject might have their due weight and force, he gave liberty to a most valuable male slave, then in the prime of his life, who had been bred up in the family almost from infancy." He was of an active temperament, and often expressed the wish that he might not live to be helpless. This desire was gratified, for he died after only a short illness.

No picture of him is known to exist. In regard to his physical appearance William states: "His stature was rather above the middle size, and upright. His visage was long, and his countenance expressive of a degree of dignity with a happy mixture of animation and sensibility." Concerning Bartram's ability as a naturalist there are enthusiastic opinions extant in letters by Franklin, Collinson, Colden, and others well qualified to judge.

William Bartram, after the death of his father, continued in the pursuit of natural history. The Botanic Garden was inher-

ited by his brother John, who took William into a partnership which lasted many years. After this arrangement terminated, William continued to assist his brother till the death of the latter, in 1812. The garden then descended to John's daughter Anne, the wife of Colonel Robert Carr, in whose family William resided from that time until his death. He was never married. In 1782 William Bartram was elected Professor of Botany in the University of Pennsylvania, but declined the position on account of ill health. He became a member of the American Philosophical Society in 1786, and was elected to other learned societies in both Europe and America. He was an ingenious mechanic, and, as before intimated, was skillful in drawing and painting. Most of the illustrations in Prof. Barton's Elements of Botany were from his drawings. His botanical labors brought to light many interesting plants not previously known. But this was not his only field. He made the most complete and correct list of American birds before Wilson's Ornithology, and, in fact, his encouragement and assistance were largely instrumental in making that work possible. Among William Bartram's scientific correspondents were the Rev. Henry Muhlenberg and F. A. Michaux, to whom he furnished seeds. A manuscript diary of William Bartram, presented to the Academy of Natural Sciences of Philadelphia in 1885, by Mr. Thomas Meehan, is rich in ornithological and botanical notes, and contains also weather notes and records of personal experiences which are of great interest. His death occurred suddenly from the rupture of a blood-vessel in the lungs, July 22, 1823, in the eighty-fifth year of his age. Besides his Travels, William Bartram was the author of Anecdotes of a Crow, and Description of Certhia. In 1789 he wrote Observations on the Creek and Cherokee Indians, which was published in 1851, in the Transactions of the American Ethnological Society, Vol. III.

In the old stone-house the great fireplace has been filled up, but few other changes have been made. The building is full of curious turns and cubby-holes. Connected with a cupboard in the sitting-room is a recess running behind the chimney, which furnished a safe depository in winter for specimens that frost could injure. Back of the sitting-room, in the wing of the building, is an apartment with large windows looking toward the south which was the botanist's conservatory. Here were reared such plants as could not stand a Pennsylvania winter—gathered in Florida or the Carolinas, or sent from Europe. In the grounds close to the river is a great imbedded rock, hewn flat, in which is cut a wide, deep groove. This is the nether stone of John Bartram's cider-mill. The Botanic Garden remained in the possession of Colonel Carr till about 1850, when it became the property of Mr. A. M. Eastwick. This gentleman had derived much pleas-

ure from visiting the garden as a boy, and was resolved to preserve it without the sacrifice of a tree or a shrub. In 1853 a Handbook of Ornamental Trees, by Mr. Thomas Meehan, was published, the main purpose of which, as stated in its preface, was to describe the trees then in the Bartram garden. After Mr. Eastwick's death, the fate of the garden was for some time dubious. His executors saw no duty but to get as much money out of the estate as possible. About 1880 Prof. C. S. Sargent, of Harvard University, obtained the promise of a private subscription to buy the old garden, and a price was agreed upon, but the executors withdrew from the agreement. In 1882 Mr. Thomas Meehan became a member of the Common Councils of Philadelphia and at once introduced a scheme for small parks for the city, in which the Bartram place was included. Repeated re-elections enabled him to follow the matter up, and finally, in the spring of 1891, the city took possession of the property, and put a superintendent in charge of it. The great gale of September, 1875, and some fifteen years of neglect had had their effect among the trees, but many planted by the botanist's own hands yet remain. It should be a source of gratification to all cultivators of science that this relic of the beginnings of botany in America is now assured of preservation.

Mr. W. W. Rockhill was credibly assured during his travels in Thibet that wild men were to be found in the eastern part of that country. His informant, a Mongol who had accompanied a Chinese trader in quest of rhubarb, described these savages as covered with long hair, standing erect, and making tracks like men. The author is of the opinion that they were nothing but bears; but he acknowledges that intelligent and educated Chinese, well acquainted with the appearance and habits of bears, believe that primitive savages are to be found in the Thibetan mountains; and he himself speaks of a forest fire in the Horpa country having driven out of the woods a number of hairy wild men, clad in skins and speaking an incomprehensible language. The Indian traveler Kishen Singh and Lieutenant Kreitner testify to the existence of wild men in those parts, and the former minutely describes them and their habits. It is curious, too, the Athenæum remarks, that the habitat of the wild man, whose progenitors may easily have relapsed into savagery, owing to the exceptional sterility and inaccessibility of northern Thibet and its adjacent deserts, should be the same as that of the wild camel and the wild horse, which there is good reason to believe are the prototypes of the domesticated varieties.

Mr. E. H. Man says that the little island of Chowry has for generations enjoyed the monopoly of pottery manufacture in the Nicobars. The work of preparing the clay and of molding and firing the finished vessel devolves on the female members of the community. The inhabitants of the island seem to guard their art jealously, and the value of trade-marks is recognized. No vessels are made especially by the Nicobarese for funeral purposes, but cooking-pots are among the personal and household articles that are laid on a grave after an interment. The people have no knowledge of anything like the potter's wheel.

CORRESPONDENCE.

THE WAYS OF BEES.

Editor Popular Science Monthly:

DEAR SIR: I have read Prof. E. P. Evans's article, on Progress in Lower Animals, in your December number, and it seems to me that some of the statements found therein call for the attention of a practical apiarist.

If all of them have no more foundation in fact than have those relating to bees, they furnish a very flimsy support upon which to found any kind of an argument.

I am well aware that there is a good deal of nonsense written in the name of science; but I do not remember having seen so many misrepresentations of facts, in the same length of space, in any article I ever read.

The professor says: "Beehives which suffer from overproduction rear a queen and send forth with her a swarm of emigrants to colonize, and the relations of the mother-hive to her colonies are known" (by whom?) "to be much closer and more cordial than those which she sustains to apian communities with which she has no genetic connection. Here the ties of kinship are as strongly and clearly recognized as they are between consanguineous tribes of men."

It is true that bees rear queens and swarm, but they do not rear a queen to send forth with a "swarm of emigrants"; for the young queen is not out of her cell until the old queen, her mother, is out of the hive and gone with the new colony. The "ties of kinship" are such that, should the young queen issue from her cell before the old one leaves the hive, she would usually receive a fatal sting from her mother, notwithstanding her "genetic connection," whatever that may mean. And the first young queen that gains her liberty is apt to treat her younger sisters in the same way, even before they have issued from their cells.

That the swarm after it has become settled in its new home recognizes in any way the relationship it bears to the old colony is utterly absurd, and, as every practical apiarist knows, has no foundation in fact.

The "ties of kinship" are not as "clearly recognized as they are between consanguineous tribes of men." Nay, the very opposite is true. They are not recognized at all after the swarm has become distinct and separate from the colony remaining in the hive, which is composed of the young bees with the young queen.

We are again told, "Bees readily substitute oatmeal for pollen, if they can get it." Bees can be taught to take *rye*-meal as a substitute for pollen when they can not ge pollen, but neither Prof. Evans nor any one else ever saw a colony of bees that would take "*oatmeal*" in preference to pollen. In fact, they will not take *rye*-meal at all, if they can get pollen.

However, the above quotations are not so bad as they might be, for they are harmless—that is, it will do no more injury for the people to receive them as true than it would for them to receive any other innocent absurdity in the name of science. Had it not been for the statement which follows, I should not have felt called upon to point out these mistakes of the professor. But, in further support of his argument, he tells his readers that "apiarists now provide their hives with artificial combs for the storage of honey, and the bees seem glad to be relieved from making cells, as their predecessors had done." Apiarists do not "provide their hives with artificial combs," but they do sometimes fill the frames of their hives with comb foundation; but this is the *real stuff*—beeswax—in thin sheets with an imprint corresponding to the cells. This is not "artificial comb," and the bees are not "relieved from making cells." They have the cells to build, the same as they do when they secrete the wax in their own bodies, out of which the combs are formed. The modern apiarist furnishes the wax, and saves the time and labor of the bees that would be required to secrete it; but nothing but wax will do, and some colony of bees had to secrete that wax. It can not be made by any "artificial" process.

I hardly think that there is any evidence that the bees are "glad" to get this wax. We only know that they will use it.

Some years ago Prof. Wiley wrote what he afterward called a "scientific pleasantry" for The Popular Science Monthly, if I am correct, in which he described how "artificial comb" was made and filled with imitation honey, and declared that an expert could not distinguish it from the genuine stuff. He thus gave currency to what has become known among apiarists as the "Wiley lie," of which Prof. Evans's statement seems to be an echo.

You have no idea, Mr. Editor, how much injury this little "pleasantry" has done the bee-keepers of this land. For, notwithstanding the fact that Prof. Wiley has explained, over his own signature, that this was only a joke, and A. I. Root, of Medina, Ohio, has offered one thousand dollars for a single pound of the comb, which has not been forthcoming, yet the papers and the people go on repeating this slander on an honest and reputable industry.

I have no idea that Prof. Evans thought that he was doing any industry an injury when he wrote the article referred to; but it does seem that it is high time that people who write in the name of science about bees should inform themselves as to the facts, which may be obtained from any practical and intelligent apiarist, one or more of whom may be found in almost every community.

Very truly, EMERSON T. ABBOTT.

ST. JOSEPH, MO., *December* 13, 1891.

PROFESSOR EVANS'S REPLY.

Editor Popular Science Monthly:

SIR: In reply to Mr. Abbott's strictures I may state in general that all accounts of the habits of animals contained in my paper, so far as they are not the results of my own observations, are based upon the very best authorities. In my rejoinder I shall leave my critic in the undisturbed enjoyment of his consciousness of superior knowledge, and confine myself strictly to the points at issue. I was perfectly well aware, before Mr. Abbott informed me of the fact, that the old queen goes off with the swarm before her successor is permitted to come out of the cell, and regret that in expressing myself too concisely my words convey an impression which any one who has observed bees or read Huber knows to be incorrect. For the purpose I had in view and the point I wished to illustrate it makes no difference whether the old or young queen leaves the hive; and, as I had this point wholly in mind, I did not state the minor fact as accurately as I ought to have done. In my paper nothing is said of cordial relations between the two queens; I fear Mr. Abbott is indulging here in one of those "pleasantries," which facetious gentlemen in that part of the country seem to be addicted to, when they write about such funny creatures as bees. What I mentioned was the closer and more cordial relations observed to exist between bee communities which have a genetic connection, or (as this phrase appears to puzzle Mr. Abbott) we will say between the mother-hive and its colonies. By whom has this been observed? Among others by Lenz, "a practical apiarist," and, what is more, a careful scientific observer, who kept bees, not merely to supply the market with honey, but chiefly in order to study their habits. The existence of such a relationship is recognized and referred to as a fact by no less an authority than Prof Wilhelm Wundt, who even suggests that the mother-hive and its colonies may form a sort of federation. It is somewhat arrogant, even in a practical apiarist, to denounce any statement as "utterly absurd," and to declare that it "has no foundation in fact," simply because it has not come under his own observation. I did not assert that bees "take oatmeal in preference to pollen," but that they "readily substitute oatmeal for pollen;" and, in remarking that they are "glad" to be relieved of the extra labor imposed upon former generations of bees, I reasoned perhaps rather recklessly from human analogy, and imagined them feeling as men would do under the same circumstances. Mr. Abbott insists upon it that they are sorry; if so, I am sincerely sorry for them, and would fain think of them as glad; but the practical apiarist is inexorable, and I must console myself with the reflection that we really know nothing of the state of their minds. Mr. Abbott says it is rye-meal; a German *Bienenzeitung* says oatmeal (*Hafermehl*). So far as my argument is concerned, it may be rye or oats, or "it may chance of wheat or of some other grain."

We now come to the most serious offence, and indeed the only one that seems to have constrained Mr Abbott to wield his pen in defense of a maligned and maltreated industry. I have asserted that "apiarists now provide their hives with artificial comb." Whether Prof. Wiley is the author of this statement or not I do not know, but I read it in an American scientific journal, with a full description of the manner of using it, how by revolving movement the honey is thrown out of the comb, and that the bees adapt themselves easily to the new arrangement. The interesting information was quoted by European journals of high standing; although one German paper suggested, rather maliciously as I thought, that the Yankees are a cunning folk, wonderfully productive of strange inventions, including all sorts of *canards*. Mr. Abbott now states that Prof. Wiley has explained over his own signature that his communication was only a "scientific pleasantry," a euphemism for what persons endowed with a finer moral sense call by a shorter and harsher name. But how are scientists in a foreign land three thousand miles away to know that an American professor has written, to a local paper perhaps, confessing that he is a liar, and that henceforth no one is to believe what he says? As for myself, I must acknowledge that I never before heard the statement contradicted, and I fully share Mr. Abbott's indignation against Prof. Wiley for deliberately fabricating and disseminating such a falsehood. A man so jocularly disposed and ethically slack-twisted should stop writing on scientific subjects and devote his talents as a professional "funny man" to the comical column of a country newspaper.

How artificial comb, if it could be fabricated and the bees should store it, would do injury to the bee-industry, I am at a loss to understand. In Switzerland, where honey is found on the breakfast-table in every inn, at least three fourths of it is artificial honey; and one proprietor of a large hotel recently admitted that he did not have a jar of real honey in the house. Real honey in an artificial comb is certainly preferable to manu-

factured honey that has never been in any kind of comb, but is sold in pots. Under the circumstances it seems to be rather gratuitous indignation to resent such a statement as a "slander on an honest and reputable industry."

All specialists are exceedingly sensitive to whatever touches their hobby, and unwilling to admit that they do not know all that is known about it. A few weeks ago a young archæologist called on a distinguished professor of classical archæology in a German university and stated that he was about to publish a work on a certain kind of Grecian vase. "There are no such vases," retorted the old professor. "But I have quite a collection of them which I have myself excavated," urged the young man. "They are all falsifications," was the terse and decisive answer. The simple fact was, that the old professor had never seen any vases of this sort. Rearing bees is not only a useful business, but also a fascinating study. If carried on as a specialty it suffers from the vice of all hobbies; even the practical apiarist, who hangs around hives all his life, is apt to have "a bee in his bonnet."

Yours, etc., E. P. Evans.

REMARKABLE GLACIAL GROOVINGS.

Editor Popular Science Monthly:

Sir: Several references to the fine deep glacial groovings in the rocks at Kelley's Island, Ohio, have appeared in The Popular Science Monthly, and there also appear mentions of the commendable efforts of scientifically inclined gentlemen to purchase the land and dedicate it to public uses and preservation.

There are other places where the same action should be had, among them the groovings at Watertown, N. Y., uncovered and seen where an ancient glacial stream crosses Black River. The writer has crossed the continent four times upon different routes, and observed many places where glaciation has done its work, but in no place has he observed more unique and characteristic groovings than at Watertown. Lying in one of these grooves, several feet deep, may be seen immense bowlders weighing fifty tons or more, just where a glacier stranded and dropped its burden, showing as plainly how the grooving has been done as a plow standing in the furrow where some plowman had left it would tell its story.

The field notes of the Geological Survey of New York suggest that the river at some time has deserted its channel and eroded a new one from Watertown to Black River Bay, but this is not the case; the present channel is undoubtedly the original. At the date of the survey, glaciation and its work had not been much studied; the geologist mistook glacial erosion for earlier river erosion.

Another interesting point is the fact that the present river has eroded its channel some three feet deeper since the glacial era in the hard, heavy-bedded, and sometimes flinty bird's-eye limestone.

The glacial groovings at Kelley's Island and at Watertown may both be referred to the Adirondack Glacial period, belonging to the same age and agencies. The St. Lawrence River was then blocked with ice, and turned back upon itself, emptying its floods into the Ohio River.

Visitors may find these groovings both above and below the railroad bridge of the Cape Vincent track. D. S. Marvin.

EDITOR'S TABLE.

THE ATTACK ON INTELLECTUAL LIBERTY IN GERMANY.

A THING which most certainly no one not supernaturally illuminated would have predicted has come to pass in Germany. A young man of thirty, who considers himself at once the father and the master of the German people, has intimated his good pleasure that every child in the German Empire shall have a theological education. It matters not what the parents of the children think; it matters not what the great body of the teachers think: his Majesty has made up his very mature mind, and all other minds must bow willingly or unwillingly to his decision. It is quite possible that, before the words we are now writing can appear in print, the imperial dictator may have seen the error of his ways, and may have concluded not to try the patience and self-respect of his subjects too far: none the less will it remain a notable fact that the possibility of fettering the German intellect in the most arbitrary manner should have occurred to a ruler of the German people in the very last years of the nineteenth century. We can not but argue ill for the future of a man

possessed of such overweening self-confidence. The ancient Greeks looked upon a character of this kind as probably predestined by the gods to a tragic end; and the experience of mankind has, on the whole, tended to show that their presentiment in such cases was not without foundation. Courage we admire, fidelity to principle we admire, resolute statesmanship we admire; but the determination of one man to impose his will upon a nation resembles madness rather than the exercise of any noble quality. It is hard for us in America to conceive how such a dream could have entered the head of any presumably sane man.

It is worth while, perhaps, to take this opportunity of asking the question why it is thought so very necessary to make special provision by law for the teaching of theological doctrines. The question is just as pertinent in this country as in any other; for there are many here who think such provision should be made, and who, if they could command a majority of votes for the purpose, would quickly make it. Only one answer can be given, and that is that the feeling of the promoters of such legislation is, that unless the doctrines in which they are interested are arbitrarily and compulsorily taught, they will have no chance of obtaining a lodgment in the minds of the rising generation. Faith in the home as a center of religious teaching seems to have almost wholly died out, and faith in the Church to be nearly as low; consequently the state is asked to step in and take up the task of inculcating the cardinal doctrines of Christian theology. As we pointed out last month, however, the inability of the state to do anything of the kind is an accepted conclusion with nearly all intelligent observers of the events of the time. What we may now further point out is that, were the state to attempt it, its success would mean before long the intellectual and even religious atrophy of the nation. Imagine for one moment the success of Emperor William's attempt. In twenty or thirty years the great bulk of the adult population would have gone through the official theological mill. All intellects would have been bowed to the official explanation—unanswerable because official—of the being and attributes of God. All would have bowed to the official proofs of the immortality of the soul. All would have accepted the official indorsement of ecclesiastical miracles, and the official interpretation of church history. All would have adjusted themselves to the principal historic creeds. No doubt some would have been brought up as Protestants, and some as Catholics; but as in each case the teaching was official, the effect would probably be to create a kind of imbecile readiness to admit as equally true the most contradictory positions. It is impossible, we maintain, for any person capable of reflection not to see that such a system of education would mean the death of all personal interest in, or apprehension of, the truths or doctrines inculcated. The being of God can not be proved in the same manner as the laws of chemistry; the latter admit of demonstrative proof, nobody asks for more than demonstration, and so long as demonstration is reached no one objects to the road by which it is reached; the former does not admit of demonstrative proof in the same sense, and everything depends upon the way in which such proofs as it does admit of are presented. Official teachers would, however, have to put forward their official proofs as demonstrative, and the effect would either be to deaden intellects or to turn out hypocrites by the thousand. The one and only guarantee for the vitality of theological beliefs is perfect freedom on the part of those who teach them and equal freedom on the part of those who learn them. Give to the individual intellect an infinite outlook upon the great problems of existence, and a reverential acceptance of

the cardinal principles of religion may well be evoked; but insist that definite answers must be found to these transscendent questions, and that there is just one authorized way of arriving at such answers, and you provoke revolt. The only result, therefore, of Emperor William's scheme, could it be realized, would be to fill the German fatherland with intellectual stagnation, formalism, and hypocrisy. Such, too, would be the effect here if the faint-hearts of the religious world could have their way. They would intrust the inculcation of religious truths to the public-school teachers, and would place religion on a par with geography, with this difference in favor of geography that it could prove all its statements by irrefragable evidence, while religion, though taught with an equal air of authority, could not in any similar manner prove its statements. Truly, the friends of a cause are often its greatest enemies, while those who get the credit of being its enemies are often its truest friends.

That the American people will not hand over their religion to the state to be sterilized in the public schools is now a matter of certainty, and it will be a very bad sign if anything of this kind happens in Germany. We can imagine a cynical enemy of all religion aiding and abetting the emperor's scheme, in the confident expectation that it would do more in ten years to extinguish vital religion in the German Empire than all the attacks of all the freethinkers could do in a century. We could imagine, too, that people with whom religion was a mere fashion or social badge might favor it as tending to attach a stigma to independent thought; but we can not imagine sincerely and intelligently religious people lending it any countenance. If the religious clauses of the present German education bill become law, it will be a clear sign that, to all intents and purposes, religion is dead in Germany.

SAFEGUARDS OF HEALTH.

While disease at one front of battle is ever yielding to the advances of medical skill, at another it is as surely surrendering to the progress of hygiene. To-day the physician is asked not only how the sick may be healed, but how the well may stay well. From year to year investigation lengthens the list of diseases strictly preventable, and diphtheria and typhoid only linger to mark the neglect of well-understood precautions. Vaccination has been so striking an example of what prophylaxis can do, that hundreds of eager experimenters are endeavoring to bring consumption and scarlet fever into the same category as small-pox. From maladies less serious, but much more common, the public is fast learning that immunity is largely a question of taking care of one's general health and vigor. Seeds of disease which find a foothold in an enfeebled frame are either repelled by a sound and hearty constitution or harmlessly digested by it. To maintain this happy condition wholesome food, abundant exercise, personal cleanliness, temperance in all things, and the avoidance of worry are indispensable.

There are a good many people who know their lung-tissues to be delicate, or their heart-action to be irregular, or who suffer from some other constitutional weakness. Among this class the custom is gradually spreading of consulting a physician, not when acute difficulty has arisen, but as soon as the infirmity is detected, and periodically thereafter. Not seldom health is maintained in this way and life lengthened, for it is in their early stages of development that many diseases, especially the obscure derangements of the nervous system, can be most successfully treated. Perhaps it is the daily glass of spirits, or the weekly supper party, which the physician interdicts. Quite as often it is the allurement of the stock exchange or the card-table which he has to pro-

hibit. Whatever his advice, it has incalculably more value in preventing a crisis than in dealing with it after it has come to pass. Just as the best services of the lawyer are not in advocacy so much as in steering his client clear of the courts, so the doctor finds his worthiest skill to be in keeping his patient free from the need of cure or healing.

In the task of maintaining healthful conditions, general and special, a science has grown up in which not only the physician but the architect, the sanitary engineer, the purveyor of food and drink, the manufacturer of clothing, have deep interests. This great science of hygiene is now worthily represented in the University of Pennsylvania by a special laboratory devoted to it, which was formally opened on February 22d. It has been planned by Dr. John S. Billings, who is its director. The means for carrying it on are to be credited to the liberality of citizens of Philadelphia. The laboratory contains research rooms for investigations upon air, water, food, soil, and clothing; work-shops and photomicrographic rooms, and special arrangements for demonstrating the principles and practice of heating and ventilation, and of house drainage. In addition there are ample laboratories for chemical and bacteriological research. The course of instruction embraces the whole range of sanitary science—the disposal of refuse, the management of contagious diseases, the offensive and dangerous trades, methods of vital statistics, and sanitary jurisprudence. In directing this important work Dr. Billings is assisted by Dr. A. C. Abbott, recently Assistant in Bacteriology and Hygiene at Johns Hopkins University.

All honor to the men and women who have made this noble gift to their kind! It will mean joy and life to many thousands who else were doomed to hopeless suffering and premature death.

BOGY-HUNTING.

The British mind seems prone to conjure up terrors. The proposed tunnel under the Strait of Dover, whose importance to English commerce would probably equal that of all the docks of London, is made impossible by the affrighted query, What if the French should send an invading army against us under the sea? A display of this ludicrous apprehensiveness, of more special interest to cultivators of science, was given by The Spectator in an article on the celebration of Prof. Virchow's seventieth birthday. Is such public homage as Prof. Virchow received on this occasion, The Spectator asks, "good for science or good for the world in general?" Its fear is that unworthy persons will be drawn into the pursuit of science for the sake of the applause to be won therein, and it therefore looks askance at the dawning tendency to bestow merited praise upon the achievements of scientific men. The Spectator's ideal man of science—devoted to knowledge for its own sake, or rather for his own gratification, and wholly indifferent to the good opinion of others—is a rare and regretable phenomenon. The real man of science is a human being having the same warm sympathy with his fellow-men and the same need of their sympathy and appreciation that is found in the normally constituted man of any other calling. Shall a due measure of public esteem be denied to these men lest a few undeserving persons may try to share it? The services of scientific investigators have too long been repaid with proscription or neglect. Men whose occupation is the pursuit of truth know full well what justice is; and, if they are made to feel the smart of persistent injustice and the chill of unvarying loneliness, their capacity for work will be sure to suffer from these repressing influences.

But The Spectator has another apprehension, that rises to the dignity of a well-developed bogy. The aforesaid un-

worthy persons having been drawn into the pursuit of science, it apparently assumes that they would display sufficient ability in this field to make them very dangerous. Our bogy-hunter says:

> As a rule, science turns itself away from producing what is not useful but injurious, and concentrates its attention on what is likely to benefit mankind. It helps, of course, to make war inventions more effective, but no scientific man has yet persistently searched for means of destroying non-combatants wholesale, or for sterilizing vast tracts of country as a lava-flood sterilizes them. If once, however, the tone of scientific feeling is lowered, there is no knowing how far the maleficent side of science may be developed. . . . The results of scientific discoveries intended to be beneficial are often, as it is, turned to very ill uses. What would be the result if we had hundreds of active brains consciously attempting to shape Nature's actions to evil ends?

There is probably no career that is less likely to hold any unworthy persons who might be attracted to it than the pursuit of science. A sufficient command of chemistry, for instance, to enable a man "actuated by worldly motives" to produce "an air-poison so potent as to act instantaneously over a very wide area" can not be acquired except through an amount of patient research that no such person would endure. The Spectator had better sound its warnings where they are more needed. Take the field of literature, for example. Poets receive and have long received a vast deal more of adulation than has yet fallen to the lot of men of science. We like to think of poets as persons who can utter none but fine and noble thoughts. Is there not great danger that the ambitious youth may say of poetry what The Spectator imagines him saying of science, "Here is a field in which I can exchange my brains and my assiduity against popularity and worldly position with great advantage?" Would it not be better to withhold all marks of public esteem from poets than to risk having the craft adulterated with "persons primarily actuated by worldly motives"? Nor is this all. It is well known that poetry exerts a vast influence over the passions of men. The oft-quoted saying, "I care not who makes the laws of a people if I may make their songs," tersely attests this. What dreadful deeds a populace might be incited to "if half the [poets] were primarily anxious to sell their powers [of song] to the highest bidder!" Here, indeed, is a bogy by which The Spectator might well be terrified.

LITERARY NOTICES.

Africa and America. By Alex. Crummell. Springfield, Mass.: Willey & Co. Pp. 466.

It is difficult to finish this volume of addresses without renewed interest in the condition and future of the African people. The author has not only studied the needs of the freedman in America, but through a residence of twenty years on the western coast of Africa has made himself acquainted with the Liberian colonists and many native negro tribes, and can differentiate the natural characteristics of his race from those acquired in years of bondage. He allows no rancor against those who have been its oppressors to obscure his judgment, and writes of slaveholders that they, "like all other sorts of men, were divided into two classes—the good and the bad."

Far worse than any present political injustice is the terrible inheritance of two hundred years of moral and intellectual degradation. To counteract this, an uplifting of character and industrial training are needed. The educational and material progress since emancipation disproves any idea of retrogression. According to the census of 1880, the colored population was assessed for over $91,000,000 of taxable property, and nearly 16,000 school-teachers were credited to them.

The race problem can not be settled by amalgamation nor by absorption. It is not a social question, but one of civil and political equality. Unless this is conferred upon the negro, the democratic idea is a failure. The trend of national affairs, however, is toward a fuller realization of justice, and the dwelling together of various races in amity.

Several papers treat of the condition of

the negro in America; others relate to the interests of Liberia; the Congo State; the aims of education and the lives of noted leaders. All are well thought out, and can not fail to be helpful to the people for whom they were written.

Essays upon Heredity and Kindred Biological Problems. By August Weismann. Vol. I. New York: Macmillan & Co. Pp. 471. Price, $2.

The three great names in the history of biologic evolution are those of Lamarck, Darwin, and Weismann. The first edition of this work, which was soon exhausted, appeared as a single volume, and at a much higher price. The present volume is more desirable, as one gets with it a list of references to the numerous discussions that its appearance immediately evoked, and which has continued at a high tension and without interruption in the numbers of Nature and other periodicals ever since. One can understand the cause of the intense feeling shown in these discussions by glancing at the titles of these essays which have appeared at various times since 1881: The Duration of Life, 1881; On Heredity, 1883; Life and Death, 1883; The Continuity of the Germ-plasm as the Foundation of a Theory of Heredity, 1885; The Significance of Sexual Reproduction in the Theory of Natural Selection, 1886; On the Number of Polar Bodies and their Significance in Heredity, 1887; On the Supposed Botanical Proofs of the Transmission of Acquired Characters, 1888; and The Supposed Transmission of Mutilations, 1888.

While any one of these subjects was sufficient to excite endless controversy, the last two essays were bound to bring on an irreconcilable conflict. A principle that we had regarded as settled, namely, that traits acquired by the individual during life could be transmitted to his offspring, is not only denied by Weismann, but this corner-stone of natural selection being knocked away, the edifice, to our astonishment, does not tumble, but remains just as steady without it. The author's judicial and temperate way, his admission of doubt, where doubt exists, inspires confidence in his deductions. In ending his essay on the Duration of Life, he says: "And so, in discussing this question of life and death, we come at last—as in all provinces of human research—upon problems which appear to us to be, at least for the present, insoluble. In fact, it is the quest after perfected truth, not its possession, that falls to our lot, that gladdens us, fills up the measure of our life, nay! hallows it."

In closing his essay on Life and Death he says: "Life is continuous, and not periodically interrupted: ever since its first appearance upon the earth, in the lowest organisms, it has continued without break; the forms in which it is manifested have alone undergone change. Every individual alive to-day—even the very highest—is to be derived in an unbroken line from the first and lowest forms."

It is impossible within the limits of a brief review to make even an abstract of the writer's arguments. The low price of the work enables every student to possess it. To the few remaining opponents of evolution among thoughtful students who are unfamiliar with the facts and details cited, this hot discussion between the Weismannians and the Neo-Lamarckians must seem fratricidal, whereas it may be compared to a band of earnest travelers perfectly united in their efforts to reach the same goal, and, coming to a number of cross-roads, heatedly discuss which is the right road, firmly resolved to follow that when demonstrated, even if many have to finally retrace their steps in order to do so. The acrimony and satire which have been excited by these discussions are in consequence of the fact that there is no half-way ground upon which the combatants can unite. It must end in absolute defeat to one or the other side. Great credit is due to Edward B. Poulton, Selmar Schönland, and Arthur E. Shipley, all accomplished biologists, for their connection with the work as editors.

The Story of the Hills. By Rev. H. N. Hutchinson. New York and London: Macmillan & Co. Pp. 357. Price, $1.50.

The simple description on the title-page of this work—"a book about mountains for general readers"—aptly characterizes the contents and style of the volume. The author has written especially for those who enjoy mountain scenery, and has aimed to heighten their enjoyment by increasing their understanding of what they see. He has

not, however, put so strong an infusion of science into the book as to make it distasteful to those who read chiefly for pleasure. The first part of the book is descriptive, dealing with "the mountains as they are," and in the latter part is told "how the mountains were made." Throughout the volume are scattered bits of picturesque description quoted from enthusiastic lovers of mountains, illustrative anecdotes, and fragments of verse. The style is everywhere clear, and the language is simple, few terms being employed that are not in the vocabulary of every cultivated person. The text is illustrated with sixteen full-page pictures from photographs by W. Donkin, J. Valentine, and others. The Story of the Hills will add much to the reputation which the author has gained through his Autobiography of the Earth.

Geological Sketches at Home and Abroad. By Archibald Geikie. New York: Macmillan & Co. Pp. 332. Price, $1.50.

These fourteen papers consist of popular accounts of geological explorations, with a few essays and addresses on geological subjects. Several of them have been thought of sufficient general interest for publication in the popular periodicals Good Words and Macmillan's Magazine. The first of these sketches describes the author's earliest geological excursion, and contains some striking testimony as to how science was taught when Prof. Geikie was a boy. Other papers describe excursions in Scotland, France, Norway, the Yellowstone Park, and Wyoming. The text is illustrated with views of many of the places visited, and with geological diagrams.

School and College. Edited by Ray Greene Huling. Monthly. Boston: Ginn & Co. Price, $1.50 a year.

The first number of an educational magazine with the above name appeared in January. It starts as a periodical of high grade, under the editorship of the principal of the high school at New Bedford, Mass., who is well known as an educator and a writer on educational topics. The opening article of the January number is by E. Benjamin Andrews, President of Brown University, on Some of the Next Steps forward in Education, and is characterized by a fullness of progressive spirit. James H. Blodgett, of the Census Office, contributes a statistical paper on Secondary Education in Census Years. There is a descriptive article on The Greek Method of performing Arithmetical Operations, by John Tetlow, head master of the Girls' High and Latin Schools, of Boston, which is illustrated with diagrams. B. C. Burt, of Ann Arbor, discusses the question When should the Study of Philosophy begin? There is also an editorial department, in which Co-operation in Entrance Examinations and Compulsory Greek in England are discussed; departments of News from Abroad, and Home News, the latter containing statistics of college attendance in 1890–'91; also departments for Letters and Reviews.

Star-land. By Sir Robert Stawell Ball, F. R. S. New York: Cassell & Co. Pp. 388.

The Royal Institution of Great Britain provides at each Christmas season a course of juvenile lectures. In 1881, and again in 1887, the course was given by the Royal Astronomer of Ireland, who has embodied his lectures in the present volume. The several lectures deal with the sun, the moon, the inner planets, the giant planets, comets and shooting-stars, stars, and to these has been added a chapter, with the title How to name the Stars, telling how to recognize the constellations. Since the lectures were prepared for an audience of children, their style is simple, though not childish, and many adults could get a better understanding of the outlines of astronomy from this little book than from more dignified treatises. The text is illustrated with nearly a hundred pictures.

The Microscope and its Revelations. By the late William B. Carpenter, M. D., F. R. S. Seventh edition. Revised by W. H. Dallinger, F. R. S. Philadelphia: P. Blakiston, Son & Co. Pp. 1117.

The great advances in the application of mathematical optics to the construction of microscopes since the appearance of the sixth edition of this cyclopedic work have made necessary a recasting of a large part of the treatise. The editor states in the preface, somewhat paradoxically, that the first five chapters of the last edition are rep-

resented in this one by seven chapters, two of which "are on subjects not treated in any former edition." In the second chapter, on the Principles and Theory of Vision with the Compound Microscope, the results of the past twenty years' labors of Dr. Abbe, of Jena, have been summarized in a manner that has received Dr. Abbe's hearty commendation. In treating many of the other topics Dr. Dallinger has had the aid of eminent specialists. The book is increased by two hundred and fifty pages over the size of the last edition. Great pains have been taken to bring the text up to the most recent knowledge of experts, and the illustrations have been increased by the addition of nineteen new plates, many being colored, and three hundred woodcuts, making the whole number over eight hundred.

The Phosphates of America. By Francis Wyatt. New York: The Scientific Publishing Company. Pp. 187. Price, $4.

The best evidence of the usefulness of this book is that a second edition was required within a week from the publication of the first. After setting forth the value of phosphates in producing fertility of soils, the author describes in successive chapters the deposits of phosphates and the modes of mining them employed in Canada, South Carolina, and Florida. Lists of companies engaged in phosphate-mining, with their capitalization, are given, also the expenses of working, the equipment required, and the selling prices of the products. These chapters are illustrated with many views of mines, drying-sheds, and machinery for handling and treating the ores. The manufacture of sulphuric acid is then described, after which the making of superphosphates is treated, and a final chapter contains methods of analysis of the materials and products of these manufactures. The author states that the volume embodies many facts, figures, and suggestions resulting from long observation and an extremely varied practical experience, and he trusts that it will prove highly profitable to all classes of persons interested in the production, manufacture, sale, and consumption of commercial fertilizers. He has aimed to couch the information in common language, avoiding, as far as possible, chemical formulas and technical terms.

The first volume of a monograph on *The Tannins* has been published by Prof. *Henry Trimble* (Lippincott, $2). It contains chapters on the discovery, general characters, and the detection and estimation of tannins, followed by a detailed treatment of gallotannic acid. An index of authors, an index, or more properly a chronological table, of the literature of tannin, and a general index to the volume, are appended.

The *Experiments arranged for Students in General Chemistry*, by Profs. *Edgar F. Smith* and *Harry F. Keller* (Blakiston), has reached a second and enlarged edition. It is adapted to beginners, and is not intended to displace the instructor, but rather to assist him. References are made to Richter's Inorganic Chemistry, but any other suitable book may be used instead. Thirty-seven diagrams of apparatus are given, and questions and problems are interspersed throughout the directions for experiments. The volume is interleaved with blank leaves for notes.

Radical Wrongs in the Precepts and Practices of Civilized Man, by *J. Wilson* (the author, Newark, N. J., $1), is devoted to condemning practices of modern social life that, in the opinion of the author, are wrong. Mr. Wilson denounces war, cruelty to animals, capital punishment, private ownership of land, taking payment for the use of money, disposing of property by will, etc., with equal emphasis.

The second volume of the exposition of the *Hermetic Philosophy*, by an editor who signs himself in an enigma (*Styx, of the "H. B. of L."*), is published by the J. B. Lippincott Company, Philadelphia ($1). The work as a whole includes lessons, general discourses, and explications of "fragments" from the schools of Egypt, Chaldea, Greece, Italy, Scandinavia, etc., designed for students of the Hermetic, Pythagorean, and Platonic sciences, and Western occultism. The present volume contains the second lesson on the Principles and Elements of Things, and a discourse from Porphyry on Auxiliaries to the Perception of Intelligible Nature. The introduction comprises a notice of Sanchoniathon, the ancient Phœnician philosopher and historian, and the text of the fragment of his Cosmogony and Theogony which has been preserved by Eusebius; and the dis-

course by Porphyry is preceded by a notice of that writer.

Mr. *Andrew J. Rickoff*, in preparing the *First Lessons in Arithmetic* (American Book Company, price, 36 cents), has endeavored to promote clear, accurate, and thorough work in the four fundamental rules and the training of the judgment in the proper application of those powers. It is divided into three parts, of which the first is devoted to exercises—each number being studied in all combinations—in numbers not greater than ten. All the processes are graphically illustrated with diagrams arranged so as to resemble the dots on dominoes. Part II deals with units and tens, with the graphic method continued. After the study of the number fifty, equal parts—halves, fourths, and eighths—are considered. Familiar measures are introduced. In Part III the treatment of numbers up to one hundred is completed, the pupil is carried through the four fundamental rules in the higher orders, and is familiarized with their application to simple business transactions. No abstract reasoning or intricate problems are introduced. Training to reckon rapidly and accurately is mainly sought, and the book is intended to systematize and facilitate rather than to supersede oral instruction.

A useful manual of *Cookery for the Diabetic* has been prepared by *W. H.* and *Mrs. Poole*, and is published by Longmans, Green & Co. (price, $1). In explanation of its purpose Dr. F. W. Pavy says, in a preface which he has written for it, that it is necessary to frame the dietary in diabetes so as to exclude as far as practicable certain principles of food which enter considerably into the dietary of ordinary persons. The basis or material part of a dish placed upon the table may be permissible, but accessories introduced in the cooking of it may render it objectionable. Diabetics are often in this way deprived of many of the properties which render food palatable and attractive, and reduced to a monotony of a few dishes of the plainest character. Mr. and Mrs. Poole seek to relieve them from this inconvenience by furnishing them with recipes by which their food may be given pleasant seasoning and at the same time harmless to them, and its variety may be increased.

The distinctive features of the *Inductive Latin Primer* (American Book Company) of *William R. Harper* and *Isaac B. Burgess* are that the lessons are shorter than those of the Inductive Method of the same authors; formal grammar is reduced to a minimum, and is introduced more slowly; no reference is made to the grammar during the early lessons; the exercises are easy and copious; prominence is given to conversation upon the text; maps, plans, and pictures are introduced; and a treatment of English grammar, inductive in character and adapted to those who never studied English grammar before and to the needs of those studying Latin, is bound with the Latin lessons. The work is based upon the connected text of Cæsar.

Russian Traits and Terrors are vividly portrayed in a book of that name, which professes to be a faithful picture of the Russia of to-day; published by B. R. Tucker, Boston (35 cents). The author's name, if it can be called that, is *E. B. Lanin*, which we are told, however, is the collective signature of several writers in the Fortnightly Review. An unpleasant picture enough is given of lying, fatalism, sloth, and dishonesty as Russian characteristics; of the condition of Russian prisons; of a low stage of sexual morality; of the miserable situation of the Jews; of Russian finance, which is represented as a "racking of the peasantry." To all this is added an ode by Swinburne, written after reading the account of the prisons.

Homilies of Science (Open Court Company, Chicago) is a collection of papers on subjects related to religion, which were first contributed by the author, Dr. *Paul Carus*, as editorial articles in The Open Court. The principle that pervades the papers is to preach an ethics that is based upon truth and upon truth alone. The homilies are declared not hostile toward the established religions of traditional growth, but toward the dogmatic conception only of those religions. They are also not hostile toward free thought, but, standing upon the principle of avowing such truths alone as can be proved by science, they reject that kind of free thought only which refuses to recognize the authority of the moral law. The author accounts for his position on these matters by relating that in childhood he was a devout and pious Christian; on growing up, he re-

solved to be a missionary; studying for that, he lost his faith in dogmatic Christianity, but found his religious ideals purified, and became a missionary of a religion which knows no dogmas; which is not in conflict with Christianity; which can never come in conflict with science, and is not in conflict with any other religion; "for it is the goal and aim of all religions."

Very different from the reverential spirit of Dr. Carus's Homilies is the tone of Mr. *G. H. Martin's Antidotes for Superstition*, which comes to us from Watts & Co., London, and which we can only describe as a vehement attack on Christianity, its origins and purport. In the first chapter—on Christian Veracity—the charge is made that the method of teaching biblical history and chronology in the seminaries "is one of organized misrepresentation and systematic concealment of facts," and that the rest of Christian instruction is of the same kind. In the second chapter the essential spirit of Christianity is described as "a most malign, subtle, and Protean spirit." The assignment of other similar traits is followed by attempts to show, in Christianity before Christ and Pre-Christian Gospels, that what is good in Christianity is of more ancient origin and is common to pagan religions; and by "ammunition for our recruits" in the shape of supplied answers for persons unskilled in debate, to the arguments of the apologists for Christianity.

The *Commission of Fish and Fisheries* has issued the *Report of the Commission for 1887*, which covers the whole of that year and the first half of 1888. Future reports will cover the fiscal year of the Government instead of the calendar year, as heretofore. In the summer of 1887 occurred the death of Prof. Baird, who had been commissioner since 1871. The duties of the office were performed for about six months by Dr. G. Brown Goode, and the Hon. Marshall McDonald was then appointed commissioner. The work of the eighteen months covered by this volume is reviewed in the commissioner's report, and to it are appended an account of the Fisheries of the Great Lakes, by H. M. Smith, M. M. Snell, and J. W. Collins; a Report upon the Division of Fisheries, by J. W. Collins; reports on the distribution of fish and eggs by the commission, and on the work of the steamer Albatross; reports on the construction and equipment of the schooner Grampus, by J. W. Collins; on the operations of the Grampus, by J. W. and D. E. Collins; a Review of the Labroid Fishes of America and Europe, by David Starr Jordan; a paper on Lake Superior Entomostraca, by S. A. Forbes; and one on Entozoa of Marine Fishes of New England, by Edwin Linton. All these papers are fully illustrated.

The *Sixth Annual Report of the Commissioner of Labor*, being the report for 1890, is devoted to statistics of the cost of producing iron and steel. It makes a volume of fourteen hundred pages, and is divided into three parts, of which the first gives the cost of labor, raw materials, and other elements that enter into the total cost of production; the second is devoted to the time and earnings of laborers, and the efficiency of labor; while the third part, comprising eight hundred pages, shows the cost of the laborers' living, in detail. Establishments in Great Britain and on the continent of Europe, as well as in the United States, were included in the investigation. This is one of the reports on the cost of producing dutiable articles which are called for in the act of Congress establishing the Department of Labor, and throws a vast amount of light upon the question of how much protection the iron and steel industries need in order to continue the present wages of American workmen.

The fifth of the lists of special classes of novels, compiled by *W. M. Griswold*, is a *Descriptive List of British Novels* (the author, Cambridge, Mass., $2), comprising over nine hundred titles. Each entry is accompanied by from a few lines to half a page of description, which in most cases is taken from a review in some prominent literary periodical. We can join heartily with Mr Griswold in the hope that "the publication of this and similar lists will lessen, in some measure, the disposition to read an inferior *new* book when superior *old* books, equally fresh to most readers, are at hand." There are no antiquated books in the list before us—the oldest that we note are some of George Eliot's which appeared in 1859 and 1860. Surely no apology is needed for going back far enough to include these.

The Bacteriological World and Modern Medicine, formed by the fusion of the two journals whose united names it bears, issued the first number of its new series in November, 1891. It is edited by *Paul Paquin*, M. D., and *J. H. Kellogg*, M. D., with a large staff of collaborators (Battle Creek, Mich., $2 a year). Among the contents of the three numbers before us are continued articles on Influence of the Continuous Current on Microbes, by MM. Apostoli and Laguerrière, with illustrations; The Influence of Dress in producing the Physical Decadence of American Women, by J. H. Kellogg, M. D., illustrated with pneumographic tracings, outlines of natural and constricted forms, etc.; Lessons in Bacteriology, by Paul Paquin, M. D.; and The Application of the Microscope in Medical, Medico-legal, and Legal Difficulties, by Frederick Gaertner, M. D. There are also shorter articles, notes, reviews, editorials, etc. The journal has as a department the bulletins of the Medical and Surgical Sanitarium, and of the Laboratory of Hygiene connected with it. In addition to the other illustrations, each number contains one or two colored plates.

A *History of Circumcision* has been published by *P. C. Remondino*, M. D. (F. A. Davis, $1.25 and 50 cents), extending from the earliest times to the present. The author describes the Hebraic and other modes of performing this operation, and argues strongly in favor of the practice, setting forth a great many annoyances and diseases to which the presence of the prepuce contributes, both in early and in later life. The book contains also descriptions of infibulation, muzzling, and other operations that have been practiced on the prepuce, and histories of castration, eunuchism, hermaphrodism, and hypospadias. The work gives abundant evidence of having been carefully prepared, and can not fail to be of service to the surgeon. It contains much information, moreover, that would benefit lay readers, and the author's declared intention of making the volume "readable" has been very successfully carried out. Over a hundred notes to the text, a list of works quoted, and an index are appended; there are also two illustrations, one of Hebraic and the other of Egyptian circumcision.

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Black, George Ashton. History of Municipal Ownership of Land on Manhattan Island. New York: University Faculty of Political Science. Pp. 83, with Plates. 50 cents.

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Coltmar, Robert. The Chinese. Philadelphia: F. A. Davis. Pp. 212. With Plates.

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POPULAR MISCELLANY.

The Peabody Museum of Archæology.— The Peabody Museum of American Archæology has received for current expenses since 1881, when the first gift was made to it, $27,801. The gifts amounted to an average of $3,089 a year. The permanent fund for the support of the museum gives an income of $2,376 a year. At no time has so much interest been taken in the work of the museum or in aid of its explorations as during the past two years. Important additions have been made to the building, and improvements in the arrangement of the collections. Among the results of the various works are additional discoveries of palæolithic implements in the Trenton gravel by Dr. Abbott, and of others from the older or Columbian gravel by Dr. Cresson; discoveries by Mr. Ernest Volk in relation to the early people of the Delaware Valley; explorations by the curator of burial-places of Massachusetts Indians at Winthrop; of Seneca Indians in the Genesee Valley; and of village sites of Indians in the Potomac Valley, with recovery of chipped stones and implements in various stages of manufacture from an ancient workshop. The Serpent Mound Park has been completed, and the hay crop and the discriminate cutting of timber from parts of the land will help bear the expense of maintaining it. A collection and several important objects have been received from Mexico, Yucatan, and Santo Domingo; crania of Zuñi and of a Tierra del Fuegian; the sacred pole of the Omaha Indians, with the scalps of noted enemies of the tribe, the sacred pipe, arrows, etc.; Peruvian pottery and pottery vessels, stone implements, and carved stones from Chiriqui; implements, weapons, masks, etc., from New Guinea and several islands of the Pacific; casts of M. Desiré Charnay's collections of the Lorillard Expedition to Yucatan and Mexico; and copper implements from the province of Tobasco, Mexico, which will form an important link in the chain of evidence upon the working of stone in Mexico and Central America. Continued explorations in the Little Miami Valley have resulted in the discovery of some ancient hearths half a mile below the Turner earthworks, which furnish evidence of the occupation of the bottom lands at different intervals during the formation of the deposit that fills the valley. The Turner earthwork has now been thoroughly explored; more so, perhaps, than any earthwork in the country. In the last mound examined, large flint points of peculiar shape, handles made of antlers, and specimens of the objects called gorgets made from a stalagmitic or fibrous gypsum, were found — all unique. Another curious work has been examined at Foster's, about twenty miles above the Turner group. It is a circumvallation more than half a mile in extent, made up of a carefully laid wall of flat stones, loose

stones behind it, and behind and over these a mass of clay burned to all degrees of hardness. The curator pronounces it one of the most remarkable structures he has ever seen. Lectures and instructions have been delivered on some of the subjects cherished by the museum, and an outline of a course of American archæology and ethnology for advanced students is published in the report. The most important of the later gifts is one by Mrs. Mary Copley Thaw, of Pittsburg, for a fellowship fund, of which Miss Alice C. Fletcher is to be the first beneficiary.

The Harvard Observatory Time-Service.—In giving notice of the discontinuance, after the end of March, of the time-service furnished by Harvard College Observatory, Prof. Pickering has taken occasion to give a brief history of the operation of this branch of the observatory's work. It has been maintained for nearly twenty years, and has given continuous signals—that is, signals throughout the twenty-four hours, instead of for a short time each day—to the cities of Boston and Cambridge, the railroads centering in Boston, and the Western Union Telegraph Company. Through the latter agencies the signals were distributed over a large part of New England and to New York city. The subscriptions of the city of Boston and the railroads, and the receipts from jewelers who timed their clocks by the signals, were sufficient to defray the cost of furnishing the exact time, and for some years formed a source of revenue to the observatory, while no charge was made to the city of Cambridge or the Western Union Telegraph Company. The observatory was one of the foremost and most earnest promoters of the adoption of standard time, although its revenues were likely to be diminished by it. One of the greatest advantages of the time-service to the observatory was that it kept before the public the practical value of astronomical work. Many thousands of persons, who take no interest in a work of a purely scientific character, realize the great financial value to the public of an accurate standard of time. The observatory desired to confer this benefit on the public, and would have been ready to do so, even at a financial loss; but recently the time signals of the United States Naval Observatory have been offered to the public at very low rates, through the Western Union Telegraph Company, and the Harvard College Observatory is relieved of the duty. The expense of furnishing the time is borne by the people through a Government appropriation. A time-service, under which the people at large within its sphere were supplied at the expense of a few who received special benefits from it, gives way to a system under which these special interests are supplied free by taxation of the whole people.

Preservation of Delicately Colored Specimens.—A mounting fluid for specimens compounded by Mr. Haly, of the Colombo Museum, Ceylon, proves to be also an excellent medium for preserving the colors of fish and other animals. It is composed of cocoanut oil and carbolic acid. The most tender frogs and snakes, the delicate plum-like bloom on the geckoes, the fugitive reddish tint on certain snakes, are not injured but are beautifully preserved by it. Preserved fish-skins can be packed away in it for an indefinite period, and, although they do not preserve their sheen like fish in the oil itself, they maintain a silvery and natural appearance, very different from that of ordinary museum specimens. It appears to be an excellent preservative for crustacea, the higher orders of arachnids and centipeds, but has hitherto proved a failure for marine invertebrates in general. The perfect miscibility of the two liquids opens up endless possibilities. The absolutely unevaporable nature of the liquid, apart from its other qualities, makes it invaluable in a tropical climate. The acid makes it possible to mix cocoanut oil and turpentine, and thus is formed a splendid microscopic fluid, in which objects may be allowed to soak, without any previous preparation, and in which they become very transparent.

Cultivation of the Bermuda Onion.—The Bermuda onion is raised, according to Mr. Russell Hastings, in Garden and Forest, in a temperature which from November to June ranges from 50° to 75°, never higher, never lower, with never a greater monthly range than 25°, or a greater daily range than 14°. Its value lies in its mild and delicate flavor,

as well as in the unusual season at which it is fresh. The seed is all grown in Teneriffe Island, of two varieties, one producing white and the other red bulbs. The white bulbs are a little earlier, but the red ones are sweeter. The seed is sown very thickly in seed-beds—the soil of which has been prepared with special care and highly enriched—from the last of September till early in November. The plants are transplanted in December and January. The fields are little pockets of earth scattered here and there over the island, in depressions between the rocks. They seldom contain an area of more than two acres, and the larger proportion of them contain less than half an acre. The soil is carefully prepared and laid out, by treading paths into beds about three feet wide, into which the little plants, about as large as a goose-quill, are transplanted from the seed-beds. The whole number of acres cultivated on the island of Bermuda in the winter of 1890–'91, in onions, potatoes, tomatoes, and beets, was 2,422.

Manufacture of Silk Gauzes.—Silk gauzes are manufactured by a special method distinct from all other modes of weaving, in which, according to M. G. Henneberg, of Zurich, the first consideration is the selection, from among the best brands of raw silk, that which will give the most uniform and the firmest twist. The twist is obtained by spinning two threads, one upon the other, about a thousand turns to the metre of length. When the threads intended for the chain have been stretched uniformly with the most delicate care, to prevent a premature wearing away (which occurs when the tension is unequal, by the two light threads snapping) each of the threads of the chain is passed separately between two meshes of the weaving harness, and between the teeth of the comb or of extremely fine steel. To show how carefully this work must be done, we mention that a steel comb used in weaving a gauze one metre wide, No. 17, has 6,517 teeth, with as many spaces between them. Next is the preparation of the chain for the operation of weaving, by moistening it with soft brushes. Some of the valleys of eastern Switzerland, on account of their elevated position and special climatic and atmospheric conditions, seem particularly well adapted to the weaving of a strong twist, exceptionally brittle and hard. The weavers do their work in couples or threes in specially constructed cellars abundantly lighted and aired, the temperature of which should be kept nearly the same—about 50° Fahr.—through the whole year, and the moisture seventy-five per cent. Whenever a notable variation in temperature takes place, the weaving should be stopped till a favorable change occurs. The weaver should be a strong, hearty man, because the management of the loom demands much skill and a more than ordinary toughness of body. When the piece is done, it is washed, stretched on a frame to dry, and dried by drawing a pan of hot coals back and forth under it. Silk gauze must be kept in perfectly dry and well-aired places.

Habits of the Wandering Albatross.—Of the wandering albatross (*Diomedea exulans*) a Mr. Harris, who has carefully studied it, says that at a certain time of the year, between February and June, the old birds leave their young and go to sea, not to return till October, when they arrive in large numbers. During their absence the young birds never leave the breeding-ground. Immediately after the return of the old birds, each pair goes to its old nest, and, after a little fondling of the young one, turns it out and prepares the nest for the next brood. The deserted young ones are in good condition and very lively, being frequently seen off their nests exercising their wings; and when the old birds come back, a young bird will often remain outside of the nest and nibble at the head of the old one, until the feathers between the beak and the eye are removed, and the skin is made sore. The young birds do not go far from land till the following year, when they accompany the older ones to sea.

Railway Accidents for 1889–'90.—According to the statistics of the Interstate Commerce Commission, the total number of passengers, employés, and other persons not trespassers, who suffered death or injury on railroads in the United States during the year ending June 30, 1890, was 29,196, of whom about five sixths were employés. The number of casualties to employés was greater by

2,845 than in 1888-'89, and greater by 2,627 than in 1887-'88. The number of casualties to passengers was 255 greater than in 1888-'89, and 258 greater than in 1887-'88. In each class the number killed is about one tenth of the number injured. The largest number of casualties occur to employés engaged directly in handling trains. Thus, while trainmen represent but 20 per cent of the total number of employés, the casualties sustained by them account for 58 per cent of total casualties. A passenger riding continuously at the rate of 30 miles an hour might expect immunity from death by railway accident for 158 years; but an engineer, a brakeman, or a conductor, under the same conditions, is liable to a fatal accident at the expiration of 35 years. The most common accident to which railway employés are liable results from coupling and uncoupling cars. Railway travel is found to be least safe in the States south of the Potomac and Ohio Rivers. In the Western territory railway employment and travel are slightly safer than in the Southern States, while the smallest proportion of accidents occur in the States east of Illinois and north of the Potomac and Ohio.

The Power of Water in Motion.—After an elaborate series of computations, Prof. Samuel B. Christy, of the University of California, concludes that if a nozzle of from six to nine inches diameter were specially arranged to throw a stream of water vertically upward against a spherical bowlder of quartz weighing 1,000 pounds, the vertical head being anywhere from 100 to 500 feet, the bowlder would be forced up until the diminished velocity of the stream established an equilibrium of pressures. There would be a point at which the upward pressure of the stream would exactly balance the gravity pressure of the bowlder, holding the rock suspended. In practice, of course, the bowlder could not be balanced accurately upon the axis of the stream, but would fall to one side or the other. But if a large conical basket of iron bars were arranged about the nozzle so as to catch the bowlder whenever it should be deflected from the stream, and return it to the nozzle, the 1,000 pounds of quartz would be kept in play like a ball in a fountain. As to cutting these streams, Prof. Christy says that he has often tried to drive a crowbar into one of them. The stream felt as solid as a bar of iron, and, although he could feel the point of the crowbar enter the water for perhaps half an inch, the bar was thrown forward with such force that it was almost impossible to retain it in the grasp. An axe swung by the most powerful man could not penetrate the stream; yet, it might be cut by the finger of a child, provided the child were seated in a railway train moving parallel with the stream in the same direction and with the same velocity, which would be considerably more than a mile per minute.

Chinese Roads.—According to a communication by the United States minister in Pekin, road-making has not been brought to great perfection among the Chinese. The country abounds in water-ways, and roads receive the less attention. Human carriers being cheaper than beasts of burden, the need of roads over the mountain passes is not so seriously felt as it otherwise would be. In southern China, at the centers of the tea trade, the long string of coolies bearing down from the hills the leaves, in deep baskets slung on poles, is a familiar sight. In northern China, where water-ways are not so numerous as in the south, intercommunication has always presented serious difficulties, which no attempt has been made to overcome. Bridges have been built over some smaller streams, but are not kept in repair. The large rivers are to be crossed by ferries only, the smaller ones to be forded. In some places there are bridges, too narrow to be crossed by carts, where the mules are taken out and led singly, while the carts are carried over on men's shoulders. In times of flood there is frequently no way of crossing. Intelligence is conveyed between the capital and outside provinces by an elaborate system of post stations thirty miles apart, where relays of horses are kept in readiness for the imperial courier. By these means dispatches have been sent to distant capitals at the rate of two hundred and fifty miles a day. The express courier from Gartok to Lhara, in Thibet, a distance of eight hundred miles, travels night and day, and is not relieved. His clothes are sealed on him, and can be removed only after the seal has

been broken by the proper official. The messengers are lifted at the post station from one horse to another, and sometimes die on the way from exposure and fatigue. Over some mountain roads, which would otherwise be impassable, considerable work has been done and money expended. In some places the paths have been paved for foot-passengers, and in others provision has been made for the passage of carts. Most of these roads date from very remote periods, but there are occasional instances of recent construction and repair.

Forest Growth after Fire.—In an article in Zoe, quoted in Garden and Forest, Mr. T. S. Brandagee describes the vegetation that grows on ground over which forest fires have run, particularly in Colorado, Montana, and on the Pacific coast. Trees have a power of resisting fire proportioned to the thickness of their bark. The redwood trees of the forests of the California coast, when they are killed or burned to the ground, send up new shoots from their roots, which soon surround the old stems with a luxuriant growth; the parent stem disappears in time, leaving only the circular groves characteristic of the redwood. The forests of Douglas fir in the coast region of Oregon and Washington destroyed by fire are in time replaced by countless seedlings which under favorable conditions grow very rapidly. The mountainous region is usually more commonly covered with a new growth than regions of lesser altitudes, although the new growth is not always at first the same as that of the original forest. Fire is very apt to destroy in the mountain regions the seeds of conifers, for seedlings do not appear immediately on the site of a coniferous forest, although trees of the original species gradually appear growing under the shade and protection of bushes, aspens, and other plants which first cover the burned ground. That fire is the principal cause of this change of forest composition is shown by the fact that, when the original trees are cut and fires are excluded, young trees of the same species appear at once. Many of the trees that grow in the regions where fires prevail have the power of reproducing themselves by root-suckers strongly developed. The soil loosened by fire, and enriched by the ashes of the destroyed forests, provides excellent seed-beds for the germination of the seeds of many annual and perennial plants. Hence these California burns often afford the best botanizing grounds in the State; and several otherwise rather local plants are appearing in such situations in much greater numbers and growing much more luxuriantly than they have ever been known to do before. It is not difficult, therefore, to imagine how great an influence this periodical burning of vast forest areas must have upon the composition and spread of the flora of the region.

A Hundred Miles an Hour.—New York Railroad Men publishes a symposium on the possibility of reaching a speed of a hundred miles an hour, and on the modifications in railroad appurtenances that will be required to promote such a result. Mr. J. D. Layng, of the Cleveland, Columbus, Cincinnati and Indianapolis Railroad, sees no more difficulty in raising speed to a hundred miles an hour than has been met in increasing it from thirty to sixty; and believes that it will be more difficult to get a track clear for the train than to develop a speed greater than now seems possible. Mr. George H. Thompson, of the New York Central and Hudson River Railroad, believes that a wide gauge will be necessary to secure the desired speed; "but, after the principles of railroading become better known, an ultimate railroad constructed and operated upon ultimate ideas will obtain. Forces now at work, partly physical, partly ethical, point to a broad gauge, say eight to ten feet. This gauge, outside of its adaptation to economical freight-work, will admit of large drivers, and consequent high-speed acceleration and low piston speeds." Further, Mr. Thompson believes, as a deduction from the doctrine of evolution relating to progress, that high speed will some day be in the usual order of things. Another general manager is hopeful as to high speed; but three other officers do not believe that a hundred miles an hour will be reached in this generation, if ever.

An Ant Mineralogist.—A curious coincidence is observed by M. A. Vercoutre between a statement of Pliny's and the habits of an American species of ant. The Roman naturalist relates that among a tribe in

northern India, called the Dardes, ants extract gold from mines, and adds that "metal which they have extracted during the winter, the Indians steal from them in summer when they have retired to their holes to escape the heat." The American ant (*Pogonomyrmex occidentalis*), which was studied by McCook in 1881, betrayed a similar disposition. When the colony have built their hill as a dome over their galleries, they cover the whole with small stones—fragments of rocks, fossils, minerals, etc., well fitted together in the style of mosaic, for which they go down, after the fashion of miners, to the depth of more than a yard below the surface. Now, as gold sometimes occurs in the region inhabited by these ants, we can easily suppose that their roofs will sometimes glisten with bits of that metal, which the natives might discover and take from them. The curious fact about the matter is, that these American ants are the only species known that correspond with Pliny's description. Had Pliny heard of them, and consequently of America; or did they once inhabit Asia also, and afterward disappear so completely as to be no longer known there? Or did Pliny repeat a traveler's tale, that has waited till this time for verification?

Mediæval Instruments of Torture.—A curious exhibition was held in London last fall of instruments of torture from the royal castle at Nuremberg which had been bought by the Earl of Shrewsbury and Talbot. With one or two exceptions, such as the "scavenger's daughter," no mediæval instrument of torture appeared to be unrepresented. The principal object of interest was the "iron maiden" (*eiserne Jungfrau*), which is probably the most terrible instrument of torture ever invented. It is the figure of a woman made of strong wood, bound with iron bands, opening with two doors to allow the prisoner to be placed inside. The interior is fitted with long, sharp iron spikes, which, when the doors are pressed to, forced their way into various parts of the victim's body and inflicted inexpressible agonies upon him till he died a lingering death. A trap-door was then opened in the base, and the body was allowed to fall into the moat or river below. The Scotch "maiden" of the sixteenth century was different from this, and was not an instrument of torture, but a kind of guillotine. Other objects were the racks; the "Spanish donkey," which cut the body into halves; the wheel on which malefactors were broken alive; the small lever with a sharp-toothed thumb and finger screw; the ducking-cage for bakers detected in giving short weight; the iron tongue-tearer, in the shape of a pair of tongs with screw; the Spanish "mouth-pear" or gag; and the yoke in which couples found guilty of acts of immorality were pilloried in the market-place. Of a different kind of interest are the copper mask worn by the judge of the Vehmgericht, the "drunkard's cloak and helmet," and carvings of Satan that were supposed to have been worshiped by witches. There were also manacles, body-rings, hand-screws, scourges, branding-irons, pillories, stretching-gallows, garters for torturing the legs, spiked collars, heavy chains for fastening prisoners to the wall, "mouth-openers" for slitting the tongues of blasphemers, sieves through which boiling water was poured on to the body, iron rings for fastening up criminals in public places, masks for the punishment of scolds and others, crucifixes which condemned criminals carried on their way to execution, iron mail chain gloves that were made hot before being put on, settles belonging to a torture-chamber, and many other things. A number of old prints accompanying the collection illustrated the application of some of these instruments.

Religious Ideas of Savages.—Having remarked that the conception of the Great Spirit of the North American Indians has been found not to be original with them, but suggested by the early Christian missionaries, Dr. E. B. Tylor proceeded, in a paper before the Anthropological Institute, to show that the mistaken attribution to barbaric races of beliefs really belonging to the cultivated world, as well as their development among these races under civilized influence, are due to several causes. Among them are direct adoption from foreign teachers; the exaggeration of genuine native deities of a lower order into a god or devil; the conversion of native words, denoting a whole class of minor spiritual beings, such as ghosts or demons, into individual names, alleged to be

those of a supreme good deity or of a rival evil deity. Detailed criticism of the names and descriptions of such beings in accounts of the religions of native tribes of America and Australasia was adduced, which gave in many cases direct proof of the beliefs in question being borrowed or developed under foreign influence. The problems involved in the discussion are of great difficulty, and the only hope for their full solution in many cases lies in the researches of anthropologists and philologists minutely acquainted with the culture and languages of the districts. Such researches should be carried out without delay, before important evidence, still available, has disappeared.

Character and the Voice.—Mr. Louis C. Elson remarks in the Boston Musical Herald on the effect of character or race upon the human voice as a subject that has never been well studied. It is a fairly well-known fact, he says, that certain kinds of voice prevail in certain countries: thus America produces many fine sopranos, Russia is the land of phenomenal bassos, and the sweet, high tenor must be sought chiefly in Spain; but it has not yet been quite determined as to whether climate, or diet and general mode of life, or actual distinction of race, is the cause of this definite distribution of vocal compass and timbre. The female voice in America is sharper and shriller than that of the Englishwoman or Frenchwoman, and this is especially noticeable in the conversational tone. The Englishwoman is more usually a full-toned alto than anything else; the Frenchwoman almost always is a mezzo-soprano. The peculiar style of singing a full falsetto, called *jodling*, which is chiefly heard in mountain districts, is another instance of race characteristics in vocal music. So perfectly is this singing done by the Tyrolese that the theory was held for a time that the throat of the Tyrolean might have some peculiar formation of its own, superinduced by peculiar diet and the drinking of snow-water. This has been shown by investigation to be erroneous; but since a similar style of singing is practiced in the Norwegian mountains, the Engadine, and other similar districts, it may be inferred that it results from a mode of calling the cattle, which is peculiarly high, characteristic, and penetrating, to which these people are accustomed from childhood. Peculiar types of voice may be found, upon investigation, to be rather the result of ages of peculiar usage, which finally produce traits that become hereditary, than of climate. The probability that diet may have some effect in the matter is mentioned. The voice of the American negro is distinguishable from that of the white singer, and here, perhaps, anatomy may afford a partial clew, for thick lips and a flat nose must influence the tone production in a certain degree. When these traits are absent, the tone of the colored singer is more akin to the ordinary standard of the singing of other races; and the author speaks of having heard some finely formed male Caffres sing, whose voices were not distinguishable from those of white singers. The loss of sight seems to have an appreciable effect on the voice, and, as a rule, one will find the intensely passionate character absent from the singing of the blind.

Sanitary Mistakes.—There is much in popular errors, says Dr. P. C. Redmondino, of San Diego, Cal., that helps to bring about our condition of physical degeneracy. For example, people look upon cold as their great and dreaded enemy, whereas cold—except in an extreme degree—does not and can not hurt any one primarily. To shut out the cold, which is harmless, they shut themselves in with ochlesitic poisons, as morbific and fatal in the end as the effects of alcohol and fusel oil. They have a vague idea that "catching cold" is to be avoided, but they have not the least idea of the lasting poison of ochlesis or in fomites. A man will give a friend a wide berth during the critical period of typhoid fever, but as soon as that period is passed he and his whole family will troop into the room, in blissful ignorance of the researches of Uffelmann and others into the wonderful tenacity of life possessed by the typhoid bacillus; or, so that they avoid the immediate breath of a consumptive, they live in fancied security. That this infection, as well as that of typhoid and other disease-germs, is longer lasting in a dark or north room, is not of any importance. The lady of the house, on the departure of her consumptive visitor, will at once draw the curtains and close the windows of her parlor that the

light and dust may not affect her carpets and *bric-à-brac*, perfectly unmindful that the care she bestows to protect these things is fraught with risk to the health and life of a son or daughter. She does not know, nor has she taken the pains to learn, nor has any one undertaken to instruct her, that the bacillus of such diseases as typhoid fever, diphtheria, phthisis, and most diseases which have a specific germ, can not exist and hold their identity in solar light and air, which, as has been demonstrated by Koch, kills them in from a few moments to a few hours, whereby no room is left for doubt that, by the construction of our houses and by the studied exclusion of light and air, we do most for the retention of these disease-germs, and at the same time contribute to the preservation of their vitality.

Earliest Use of the Mariner's Compass.—The history of the discovery of the mariner's compass by the Chinese is lost in their antiquities. It is supposed to have been accidental, in a province where there is much magnetic iron ore, from the observation that a needle made from that ore, when by any means it was caused to float on water, assumed a north and south direction. The earliest author who mentioned the "south-pointing needle" lived in the fourth century B. C. It probably came into use when the professors of fung shue or geomancy began to study landscape, about the eighth century of the Christian era. Their instrument was made of hard wood, about a foot wide, with a small well in the middle, in which a magnetized needle floated in water. On the compass were inscribed several concentric circles, as on the wooden horizons of our globes. They embraced the twelve double horns, the ten denary symbols, eight diagrams, and other marks. This compass was used in preparing a geomantic diagram of any spot where a house or tomb was to be constructed, so that the construction might not be upon an unlucky site, or planned in an unlucky manner. At the same time there was living a Chinese who had studied Hindoo astronomy, and was the imperial astronomer and also a Buddhist priest. He noticed that the needle did not point exactly north, but varied by 2° 5′. The variation went on increasing till a century later, or the ninth century. Shenkwa, writing in the eleventh century, mentions that any iron needle could be given polarity by rubbing it on a piece of loadstone. After this, in 1122, an ambassador to Corea described the use of the floating needle on board ship while he made the voyage. This is the earliest instance, by more than a century, of the use of the mariner's compass on board ship found in any book. At that time the needle was floated in water, supported by a piece of wood; but in the Ming dynasty some Japanese junks engaged in piracy were captured by Chinese, in which the needle of the compass was dry and raised upon a pivot. The Japanese had learned this from the Portuguese. The Chinese from that time also hung their compass-needles on a pivot.

An American Exhibition in Spain.—The Spanish Government is preparing to establish at Madrid, in honor of the fourth centennial of the discovery of America, an exhibition of every kind of American objects, so constituted as to give an idea of the civilizations of the American world, both previous to and coeval with the epoch of the discovery and the European conquests. For this purpose the commission solicits contributions of American objects illustrating prehistoric America—plans, models, and reproductions of drawings of cave dwellings, megalithic monuments, and lake dwellings, and of objects of all kinds of the palæolithic and neolithic ages, and of the bronze and copper ages. Of the historical period are wanted models or representations of buildings and architectural fragments, specimens of polychromatic architecture, representations of restored monuments, and works of fine art of every kind. In the department of industrial arts, etc., clothing and adornments of aboriginal uncivilized or only partly civilized Indians are asked for, implements of war of wood, copper, bronze, and iron; gold, silver, bone, and ivory jewels, necklaces, earrings, bracelets, etc.; pottery, household utensils, and furniture; tissues and textiles from which they are made; apparatus for manufacturing purposes; articles used in transportation; native documents; Indian portraits and effigies; models of Indian dwellings, crania, etc. Old maps, articles relating to cartography, whatever relates to

Columbus, etc., constitute another class; and the collection will be completed with representations of fine-art works, literary and scientific publications, and manuscripts, charts, and plans from the discovery to the middle of the eighteenth century. Prizes and diplomas are offered for the contributions.

The Royal Tombs of Uganda.—Dr. Carl Peters gives the following description of the more modern royal tombs of Uganda: "On approaching them from a distance the traveler thinks he sees pyramids before him, but in reality they are in the form of large cones, and are built of wood in Uganda fashion. On entering, the visitor finds himself in a dusky hall, supported by a row of columns. In the background of this hall is a painted curtain, before which are ranged the weapons and favorite movables of the deceased. On putting aside the curtain the dark area is entered, from which shafts and corridors have been excavated in the ground. In these passages textile stuffs, cowrie shells, and other articles of value, which in Uganda represent money, are heaped up. At the farthest extremity of these passages is deposited the coffin, with the embalmed corpse of the dead person. It appears that the regular procedure for preserving the corpse is by drying it, and swathing it tight in wrappings; but the Waganda also told me that they understood the art of preserving the body from decomposition by injections into the blood. In front of the curtain twelve girls watch day and night on behalf of the last one departed; at present, therefore, for Mtesa. From time to time all the great men of the land come to the dead man, with drums and fifes, to pay him a visit, as if he were alive."

Excess in Ornamentation.—In his book on the Planning of Ornament, Mr. Lewis F. Day recognizes as among the æsthetic faults of modern architecture its too free use of ornament without reference to its fitness to the other details of the structure, and relative neglect of proportion. A writer who timidly suggested lately that by a proper attention to proportion ornament might be economized, found himself out of fashion, as he doubtless apprehended. The Saturday Review enforces the precepts of the two authors, with a comparison of two buildings that stand near one another in London. Of one, the "front is composed of arches and columns — the arches of colored marbles, the columns of polished granite, the capitals of bronze, heavily gilt. Not far from it is another elevation, partly in brick and plaster, painted drab and wholly devoid of any ornament; yet the eye lingers lovingly on it. The proportions are like those of, say, one of Gray's odes, or one of Mendelssohn's songs without words. The whole façade cost perhaps seven or eight hundred pounds; but, then, it was designed by Wren. The bank front cost, at a moderate estimate, seventy or eighty thousand pounds, yet, because the architect, or, to speak more exactly, the builder, did not mix his design with a single ounce of brains, had not, in fact, so much brains to bestow upon it, all the money spent has produced so hideous a pile that one instinctively turns from it as one turns from a sudden glare or a street accident." Like contrasts may be found in almost any large town.

Amusements of Animals.—A writer in the London Spectator suggests as a logical order in which to consider some of the powers of enjoyment possessed by animals, without exaggerating or depreciating them, is to observe their development as the animal itself grows up. The faculty of amusement comes early in them. Many animals are aware of this, and make it part of their maternal duties to amuse their young. A ferret will play with her kittens, a cat with hers, and a dog with her puppies. A mare will play with her foal, though the writer from whom we quote has never seen a cow try to amuse her calf, nor any birds their young. If their mothers do not amuse them, the young ones invent games of their own. A flock of ewes and lambs were observed in the Isle of Wight in adjoining fields, separated by a fence with several gaps in it. "Follow my leader" was the game most in favor with this flock, the biggest lamb leading round the field and then jumping the gap, with all the others following in single file; any lambs that took the leap unusually well would give two or three more enthusiastic jumps out of sheer exuberant happi-

ness when it reached the other side. Another flock of lambs, confined in a straw-yard, had steeple-chases over a row of feeding-troughs stuffed with hay, right down the yard and back again. On a Yorkshire moor they have been seen to race, for a quarter of an hour, round a spring, and back to the ewes. Fawns play a kind of cross-touch from one side to the other, the "touch" in each case being given by the nose. Little pigs are also great at combined play, which generally takes the form of races. Emulation seems to form part of their amusement, for their races seem always to have the winning of the first place for their object, and are quite different from those combined rushes for food or causeless stampedes in which little pigs are wont to indulge. Racing is an amusement natural to some animals, and, being soon learned by others, becomes one of their most exciting pastimes. Many horses, and all racing-dogs, soon learn to be as keen at winning as public-school boys in a half-mile handicap. It is a common impulse with horses to pass, or at least to keep up with, any other horse in their company, and this instinct, developed by training, makes the professional race-horse eager to win. Animal enthusiasm for racing is well—the writer in the Spectator says best—seen in a dog-race. Birds especially delight in the free and fanciful use of their wings. There is all the difference possible between the flight of birds for "business" and pleasure; and many kinds on fine days will soar to vast heights for pleasure alone. In any comparison of the games and sports of animals with our own enjoyment of the same amusements, it must not be forgotten that imagination, the make-believe which enters into so much of the best play of children, is also the basis of much of the play of young animals. Watch a kitten, while you tap your fingers on the other side of a curtain or table-cloth, imitating the movements of a mouse running up and down. She knows it is not a mouse. But she enters into the spirit of the game, and goes through all the movements proper to the chase. Or perhaps she has a ball. If you set it in motion, so much the better—that helps "the make-believe." The ball is "alive," and she catches it, claws it, and half kills it, taking care all the while to keep it moving herself. The beautiful young lion, given by the Sultan of Sokoto to Queen Victoria last year, would play in exactly the same way with a large wooden ball, growling and setting up the crest, and pursuing the ball across the cage.

Durability of Oil Paintings.—Much time has been devoted by Mr. A. P. Laurie to the study of the means of insuring the durability of oil paintings. Some of the paintings of the old masters are still remarkably brilliant in coloring. A Van Eyck in the National Gallery is especially mentioned in M. Laurie's paper before the Society of Arts as having its colors all fairly well preserved, and a green—one of the most difficult of colors — wonderfully so. The quality is found not to reside in the pigments used, which were not superior to those of the present. It must, therefore, lie in the vehicle. It has been shown by Prof. Russell and Captain Abney that most fugitive pigments are permanent if protected from moisture, and a still larger number if protected from both air and moisture. If, therefore, we can obtain a vehicle which will really protect the particles of the pigment from moisture, we may use safely many pigments that are now regarded as fugitive. Mr. Laurie tested the qualities of linseed and walnut oils, the resins, and mixtures of oil and resins. His experiments showed that linseed oil, no matter how carefully refined, or in what way it is converted into boiled oil, can not be depended upon to protect a surface from moisture. Walnut oil proved no better. Solutions of resins in spirits of turpentine or benzol give as varnishes sufficient preservation from moisture for all practical purposes, but, forming a brittle and not very durable surface, are not fit to be used as mediums in place of oils. Eastlake's theory that the Flemish painters secured permanency by grinding their colors in oil and adding a little varnish, was tested and found not correct. No preparations of that kind experimented upon resisted the attacks of moisture; but a good mastic varnish was more efficient, and proved superior to any other substance tried. The use of copal or amber dissolved in spirit is also objectionable, because the varnish is difficult to remove. By using mastic, we have a varnish

which, while it affords the best protection to the picture from moisture, is easily removed and renewed. A source of danger to pictures to which not enough attention has been given is that which arises from the development of moisture by chemical action within the substance of the painting itself. An old medium of remarkable qualities has been recently discovered, concerning which nothing more is said at present, till its qualities are proved. Apparently the most durable surface that can be produced with modern mediums is that obtained with a mixture of copal oil varnish and linseed oil; and, until the proper medium is discovered, the best we can do is to paint our pictures with this medium and a carefully selected group of pigments, and then, as a further precaution, coat the pictures, when thoroughly dry, with a layer of mastic dissolved in turps (or turpentine).

Illustration of Customs.—The Pitt Rivers collection in the University Museum at Oxford is designed to illustrate the customs, life, and religious observances of primitive and semi-civilized races. The contents are arranged with a view to showing the various stages of development among different races and at different times, and to establishing direct relationship between the primitive and the modern types. The collection has also many European objects of antiquarian interest. Among them are specimens of the hornpipe, the instrument that gave its name to the dance performed to its music, and of the pipe and tambour used by the mummers at their performances. Among the exhibits relating to savage races is a collection of masks from Fiji, New Britain, and elsewhere, such as were worn at funerals by the male relatives of the deceased. In some cases the very skull of the dead man was made into masks, with the idea that he should assist at his own obsequies. The jew's-harp in many forms and developments—none, however, dating beyond the sixteenth century—has a place in the museum, together with a collection of primitive reed instruments, some of which were blown by the mouth and others by the nostrils. Of fire-kindling apparatus, the frictional fire-sticks of savages, the rather elaborate mechanical contrivance of the Brahman priests, and the apparatus used by the Vestal Virgins to kindle the sacred lamp if it should be extinguished, are shown.

Mediæval Guilds.—According to a paper in the Archæological Institute by the Rev. J. Hirst, on the Guilds of the Anglo-Saxon Monasteries, a regular system of communication was kept up between the various religious houses by means of messengers, who, being men of the world, were able to supply the news of passing events, even in the most distant countries. Other visitors to the abbeys were pilgrims, who were often admitted as brothers, and were thus enabled to participate in the benefits derived from the prayers of the community. From these sources no doubt the monkish chroniclers derived much of their information, which they so carefully recorded. The author said these ancient guilds threw a light on the origin, rapid increase, and organization of the English trade-guilds at a later period. Mr. J. T Micklethwaite pointed out a difference between these two sorts of guilds. The trade-guilds kept a common purse, whereas those attached to the monasteries did not; the absence also of the word guild in the Saxon manuscripts led him to believe that the trade-guilds were not derived from the monastic ones.

Spiders as Marplots.—A curious account is given in Engineering of the way in which the accuracy of engineering work is often impaired by spiders and their webs. When plumb lines are sunk in shafts, the spiders sometimes attach their webs to them and draw them to one side. The accuracy of a certain work in the Hoosac Tunnel was destroyed until the lines, 1,028 feet long, were inclosed in cases. It has been suggested as a remedy to apply electricity to the lines so as to burn off the spider-threads. The writer in Engineering once found his vision when using the level distorted by the appearance of curved lines in its field. After consulting an oculist and paying his fees, he discovered that the whole trouble was caused by a little spider which had settled itself in the eye-glass of the telescope of the level. An electric-light metre, of the revolving fan type, was found doing imperfect work, as it recorded only a small fraction of the electricity that was known to be used. It was found that

a spider had entered the case through a screw-hole and spun a web in such a manner as to prevent the free use of the fans.

NOTES.

We published in the Monthly for June, 1886, a sketch, by Prof. David Starr Jordan, of the eminent early American naturalist C. S. Rafinesque, for which we were not able at the time to secure an authenticated portrait. We have since found such a portrait, which was published several years ago in Potter's American Monthly, and now have the privilege, by permission of Messrs. Potter & Co., of presenting it to our readers, as a supplement to Prof. Jordan's delightful sketch. It comes in opportunely at this time to supply the lack of the portraits of the Bartrams, of neither of whom have we been able to find an authenticated likeness. As the object most closely associated with the Bartrams, we give in connection with the sketch of them a view of the house built by the elder Bartram, as it appeared in 1887, from a photograph furnished us by Mr. Thomas Meehan.

A new star, not marked on any map, was observed February 1st in the constellation Auriga, slightly in advance of the star 26 of that constellation, and of about the same, or the sixth magnitude. It is described as yellowish, and somewhat fuzzy in appearance.

OBITUARY NOTES.

Dr. Thomas Sterry Hunt, a distinguished American geologist and chemist, died at the Park Avenue Hotel, in this city, February 11th, of mitral disease of the heart, in the sixty-sixth year of his age. A sketch of his life and scientific activity, and a portrait, were given in the Monthly for February, 1876. He retired from public professional life in 1878, but had made since then many important contributions to theoretical chemistry and geology. One of the organizers of the International Geological Congress, he was its first secretary, and was a vice-president at the meetings in Padua, 1878; Bologna, 1881; and London, 1888. He was a member of the International Juries at the Centennial Exhibition in 1876. Dr. Hunt had been in feeble health for many months previous to his death.

Sir George Biddell Airy, English Astronomer Royal from 1836 till 1881, died on January 2d, after a few months' illness, in the ninety-first year of his age. A sketch of his life and works up to that time, with a portrait, were given in The Popular Science Monthly for May, 1873. He after that made the preparations for the equipment of the British expedition for the observation of the transit of Venus of 1874, a subject on which he had been engaged since 1836. He retired from his office in the Greenwich Observatory in 1881, after forty-five years of service.

M. Émile de Laveleye, the eminent Belgian economist and publicist, died at Liége, early in January, of pneumonia, following influenza. just after the publication of his latest work, Government in Democracy. He was born in Bruges in 1822, studied law in the University of Ghent, and engaged in historical and philological labors, and afterward in works on political economy and kindred sciences, which gave him a world-wide reputation. In 1864 he was appointed Professor of Political Economy in the University of Liége. His principal works were on the Rural Economy of Belgium and of Holland, on Property and its Primitive Forms, and Natural Laws and the Object of Political Economy. He was the most conspicuous advocate of bimetallism.

According to the Academy, the death of the Duke of Devonshire, in December, 1891, was a greater loss to the learned world than (directly) to politics or society. The duke had been intimately associated with academical affairs ever since he took his degree at Cambridge in 1829. "The Cavendish Laboratory at Cambridge bears witness to his munificence, while science acknowledges no less gratitude to him for serving as chairman of the Royal Commission on Scientific Instruction and the Advancement of Science."

Prof. John Couch Adams, the English astronomer and mathematician, who shares with Leverrier the honor of having predicted the place where the planet Neptune would be found, has recently died. He was the son of a farmer, and was born near Bodmin, Cornwall, in 1818. He began his investigations of the irregularities in the motions of Uranus in 1841, and completed them as early as Leverrier did his, but suffered himself to be anticipated in the publication. In 1858 he succeeded the late Dean Peacocke as Lowndean Professor of Astronomy at Cambridge.

The death is announced of Colonel James Augustus Grant, a famous African explorer. He was the son of a Scottish clergyman and was born in 1827; served in the war of the Indian mutiny; accompanied the Abyssinian Expedition in 1868 as a member of the Intelligence Department; and in 1860 to 1863, with Captain Speke, explored the sources of the Nile and discovered the Victoria Nyanza. He described this expedition in the Journal of the Royal Geographical Society, and its botany in those of the Linnæan Society; and published in 1874 a supplementary account of the expedition, of which a joint account by the two explorers had already appeared. It was entitled A Walk across Africa. He received medals from the Royal Geographical Society, the Pope, and King Victor Emanuel.

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